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OF

The Entomological Society of America

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SEPTEMBER, 1946

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Founded 1906

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ANNALS

OF

The Entomological Society of America

Volume XXXIX SEPTEMBER, 1946 No. 3

THE ENTOMOLOGICAL SOCIETY OF AMERICA

NEWS OF THE MOMENT

NEW MEMBERS

The following new members were recommended and nominated for membership in the Society since the annual meeting. They were elected to membership by mail ballot of the Executive Committee.

BEATIE, RUSSEL, Westvaco Chlorine Products Corporation, 405 Lexington Avenue, New York 17, New York.
BONHAG, PHILIP F., 134 S. Frazier Street, State College, Pennsylvania.
FOX, IRVING, School of Tropical Medicine, San Juan, Puerto Rico.
HANAN, BLAKE B., Biological Laboratory, University of Toledo, Toledo 6, Ohio.
HASBROUCK, FRANK, 303 Harker Hall, University of Illinois, Urbana, Illinois.
O'NEILL, MISS KELLIE, University of Texas, 2201A Nueces Street, Austin, 21, Texas.
SLATER, JAMES A., 1635 Maryland Drive, Urbana, Illinois.
THURMAN, DEED C., JR., 605 Volunteer Building, Atlanta, Georgia.

SOCIETY BUSINESS AND APPOINTMENTS

FORTY-FIRST ANNUAL MEETING, 1946.—Following the action of the Executive Committee in St. Louis, the President and Secretary met with the President and Secretary of the American Association of Economic Entomologists and decided on Pittsburgh, Pennsylvania, as the best selection for the 1946 meetings, pending information regarding accommodations. Since that time we have been assured of adequate accommodations by the Hotel William Penn and the meetings are set definitely for that place, from December 9–12.

Following approval of the Executive Committee, the President and Secretary are working in conjunction with the Program Committee of the American Association of Economic Entomologists in preparing a program for a joint meeting of the two societies.

PRESIDENT MUESEBECK appointed DR. H. M. HARRIS, Department of Entomology and Zoology, Iowa State College, Ames, Iowa, as the representative of the Society to the Division of Biology and Agriculture, National Research Council. PRESIDENT MUESEBECK appointed DR. S. B. FRACKER, Agricultural Research Administration, U. S. Department of Agriculture, to represent the Society at future meetings called

by the National Research Council to give further consideration to the projected Institute of American Biologists.

H. H. Ross, *Secretary.*

REPORT OF THE REPRESENTATIVE TO THE DIVISION OF BIOLOGY AND AGRICULTURE, NATIONAL RESEARCH COUNCIL

As the representative for the Entomological Society of America to the Division of Biology and Agriculture of the National Research Council, I have the pleasure of reporting that I again attended the Executive Committee meeting and the annual meeting of this Division on April 12th and 13th, 1946.

At the annual meeting on April 13th, a number of important matters were presented to the Council, including:

1. Problems of Scientific personnel. Discussion led by M. H. Trytten, Director, Office of Scientific Personnel, N. R. C.
2. Present Status of the National Science Foundation Bill, presented by Dr. Barry Commoner.
3. The Prevention of Deterioration of Equipment in the Tropics, presented by Glenn A. Greathouse.
4. The work of the Insect Control Committee, presented by R. A. Ormsbee.
5. Discussion of the projected American Institute of Biology, led by Detlev W. Bronk.
6. A conference on the Resumption of International Scientific Relations, led by Detlev W. Bronk.
7. A report on the Activities of the Division of Biology and Agriculture.

Among the important discussions was one in relation to the National Science Foundation Bill, No. S-1850. Apparently the general feeling of all those present was that this bill will be of very substantial aid in furthering research work, especially in Universities and other organized scientific groups. Although it was pointed out that the bill barely passed the committee, and that there are two other bills in competition with this bill, it was hoped that all scientific organizations and individuals would give as much support to this bill as possible immediately. The suggestion was, too, that all organizations either write or wire their state senators and also get in touch with Senator Thomas of Utah, who was very much interested in trying to secure passage of the bill. I find out that all Land Grant Colleges and many other organizations have already done this very thing, and that most scientific organizations in St. Louis sent in very strong resolutions for the passage of bill S-1850.

A great deal of discussion was also centered around the formation of an American Institute of Biology, a matter which I understand, was also discussed quite thoroughly at the St. Louis meetings. As a result of this discussion a motion was passed requesting all of the representatives of the various societies in attendance to report to their organizations to the effect that some action should be taken to appoint representatives to discuss the formation of such an organization. In looking over the reports of the St. Louis meetings and also a letter recently received from President Clay Lyle of the American Association of Economic Entomologists, I note that representatives were appointed by the entomologists for this purpose.

In years past there was considerable opposition to the formation of the Institute which I believe was first launched under the name of Union of Biological Societies. This opposition, I think, was due more to the purposes as expressed at that time and the methods of organization rather than to the idea. If I remember correctly, one of the important items for launching this Union was the support for Biological Abstracts. All of these matters have been eliminated and the present suggested Institute is not fettered by any encumbrances whatever. Therefore, it is believed that the biologists of the country will give it much more serious consideration.

Other matters which were discussed by the Council were:

1. Admission of other organizations to membership;
2. Question of frequency of meetings;

3. Closer relationships of the Council to the various societies represented;
5. A general discussion of requirements for fellowships and scholarships in general.
5. A reorganization of the insect control committee so as to be thoroughly representative of the entomological organizations of the country;
6. Methods of aiding entomologists and entomological institutions in foreign countries, and the resumption of international scientific relations, including the organization and holding of scientific meetings.

I think this was probably the most important of all the meetings I have attended. There is every reason to believe that the relationships between the various societies and the National Research Council are to be more constructive during the coming years so that, through cooperation, a great deal of benefit will accrue to all professions participating through the guidance of the National Research Council, which also reflects somewhat the personality of the National Academy of Sciences.

This, I believe, completes my two terms of three years each as your representative and therefore, I am most happy to have a successor appointed to represent the Society for the coming year. Because of having served as a member of the Executive Committee of the National Research Council my expenses in attending the recent meetings were provided for by the Council and therefore I have no expense account to present to the Society.

I wish to take this means of sincerely thanking the various presidents of the Entomological Society of America, and you as Secretary, for the honors you have bestowed upon me in appointing me as your representative. It has offered many opportunities for educational advancement and I trust that I have been able to render some service to the Society.

Respectfully submitted,

E. O. Essig, *Representative.*

OBITUARIES

William Thompson Davis, (1862–1945), American naturalist, historian antiquarian, man of affairs, and charter member since 1908, Fellow since 1917, and Honorary Fellow since 1943 of the Entomological Society of America, was born at New Brighton (now Saint George), Staten Island, New York, on October 12th, 1862. He was the son of George B. and Elizabeth (Thompson) Davis, and of ancestry that had originally settled in Massachusetts, and of which later generations had removed to Staten Island. From childhood he was interested in natural history study, particularly of birds, plants and insects. Educated in private schools, he entered early upon a business career and for some time was with a New York mercantile establishment. In 1883, at the age of 21, he became connected with the New York Produce Exchange, with which he was associated for 26 years. At the age of 38 he was married on November 7th, 1900, to Bertha Mary Fillingham, of Livingston, Staten Island. After slightly over a year of married life, she died December 7th, 1901. In 1909, at the age of 47, he retired from active business and devoted the remaining 36 years of his life to care of his property interests and to natural history, historical and antiquarian research.

He first appears to have become really interested in insects when a lad of only 15, and that these chanced to be Cicadas was stimulated by the fact that it was during the season that the 1877 brood of these insects—the so-called "Seventeen year Locusts"—emerged from the soil. In the decades that followed, his studies of Cicadas gradually increased in range and scope until, eventually, he became one of the foremost world authorities on this fascinating group of insects. It has been said in comment on his work that out of 170 Cicadas from North America known to science, he has named and described more than 100, that the oldest fossil Cicada ever found has been named in his honor, and that his Cicada collection at the Staten Island Museum has become one of the most complete in the country.

In addition to a long series of technical writings on the Cicada, he wrote on various other insects, and also was author of a popular volume on nature study entitled "Days Afield on Staten Island," 1892, revised edition 1937. Other books written by him, of historical or antiquarian interest, are "The Church of Saint Andrew, Richmond, Staten Island," written in collaboration with his life-long friend, Charles W. Leng, and another friend, Roydan Woodward Vosberg, and

published in 1925. Another volume by him, "Legends, Stories and Folklore of Old Staten Island, the North Shore," appeared in 1925, and still another entitled "The Conference or Billopp House," was published in 1926. Perhaps the most important single work published by Davis and Leng is that entitled "Staten Island and Its People: A History 1609 to 1929," and issued in four ponderous tomes in 1930.

The friendship which existed for over sixty years between Davis and Leng, until separated by death, also is worthy of special mention. Together they worked and rambled, together they pursued their hobbies, and together they spent every possible moment. They had prominent part in forming in 1881 the Staten Island Institute of Arts and Sciences, and later in the founding and development of the Staten Island Museum, an outgrowth of the former, both of which have long and honorable records of useful service.

The memberships of W. T. Davis in scientific and other societies included the Linnean Society of New York, the Academy of Natural Science of Philadelphia, the Boston Society of Natural History, and life membership in the New York Historical Society. His very considerable activity in organizations of this kind is evidenced by the fact that he was president of the Staten Island Historical Society for 16 years from 1922 to 1938 and thereafter was president emeritus; he was president of the Brooklyn Entomological Society from 1912 to 1916 and from 1920 thereafter. He was treasurer of the New York Entomological Society for a quarter of a century from 1904 to 1929, and was its president 1929 and 1930, was member of its Executive Committee 1931–38 inclusive and was elected its Honorary President from 1940 thereafter. He was president for 11 years of the Staten Island Bird Club, and was made a Fellow of the New York Academy of Science in 1910. Further, The Park Association of the City of New York conferred upon him an Official Citation in 1941 for his interest in and assistance in development of parks and nature recreation centers on Staten Island.

He died at Staten Island Hospital, Saint George, Staten Island, on January 22nd, 1945, age 82 years, 2 months, and 10 days. The remains were interred in Moravian cemetery, New Dorp, Staten Island.

Any sketch, however brief, of William T. Davis would be incomplete that did not at least make mention of his sterling qualities of character, his gentleness, his helpfulness, his tactfulness, the charm of his personality, and—manifested over and over again in countless unrecorded acts of kindness and beneficence—the simple goodness of the man. Perhaps he will be longest remembered for his historical and antiquarian work, but American Entomology too has been left definitely enriched through the example of his life and achievements.—J. S. WADE.

PETER CHASE GRASSMAN was born at Chicago, Illinois, December 5, 1925, and was killed in action on the Saarlautern Bridge, Germany, on December 4, 1944, just one day short of his 20th birthday. He removed from Detroit, Michigan, to Phoenix, Arizona, in 1933 and graduated from the North Phoenix High School in 1943.

He was an Eagle Boy Scout with palms and served three seasons on the staff of the Scout Camp Geronimo. He became very much interested in Entomology and spent nearly two years collecting, classifying, and mounting insects, chiefly beetles and moths, but he became particularly interested in the darkling ground beetles of the family *Tenebrionidae* and he was greatly aided in his studies by Frank H. Parker, Assistant State Entomologist of Arizona, who very kindly aided in furnishing information for this notice.

In the fall of 1943 he entered the U. S. Army, having qualified for the Army Special Training Program. After completing basic training at Fort Benning, Georgia, he was assigned to the Carnegie Institute of Technology, Pittsburgh, Pa., where he was enrolled in training courses until all of the A.S.T.P. students were cancelled out in March, 1945. He was then assigned to the infantry and trained for combat intelligence and was with the 95th Division during the capture of Metz. He was awarded the Silver Star and Bronze Star Medal for heroic achievement against the enemy. He was Private First Class at the time of his death.

While he was at the Carnegie Institute he was elected a member of the Entomological Society of America in July, 1944, and was one of the youngest members of our association at the time. It was most unfortunate that he was never able to

pursue the studies he was so much interested in. A new species of beetle he collected was named for him by Parker.

He is survived by his parents and a younger brother, S. S. Grassman. His mother, Mrs. Barbara C. Grassman, gave much information used in this sketch.

—E. O. Essig.

Theodore Henry Frison, a member of the Society since 1914 and a Fellow since 1929, was born in Champaign, Illinois, January 17, 1895, and died in Champaign, December 9, 1945. Dr. Frison spent most of his life in Champaign-Urbana, where he attended Champaign High School and later the University of Illinois. During his high school years, he was a neighbor of J. W. Folsom, who tutored him in his early interest in entomology. Dr. Frison's college career was interrupted in 1918 when he entered the army, was commissioned a second lieutenant and resigned in December of the same year to resume his study of entomology at the University of Illinois. There he received his B.A. in 1918, M.A. in 1920, and Ph.D. in 1923.

In 1920, after receiving his master's degree, he was appointed Assistant State Entomologist of Wisconsin. In 1921–22, he joined the staff of the Illinois Natural History Survey as Systematic Entomologist. In 1917, the State Laboratory of Natural History and the office of State Entomologist had been merged to form the Natural History Survey, with Forbes as Chief. Upon Forbes' death in 1930, Frison became acting head of the Survey and on July 1, 1931, he was named Chief, a position he has since held.

Dr. Frison was internationally known for his studies of bumblebees, aphids, and stoneflies, and he continued his work on these groups, especially the stoneflies, until his last illness.

After he became Chief of the Natural History Survey, administrative duties claimed much of his time. Under his direction, the modern laboratories and offices of the Survey in the Natural Resources Building were planned and completed. He took an active interest in wildlife research in Illinois and was one of the principal persons responsible for the organization of the Midwest Wildlife Conference, whose first meeting was held in Urbana in 1935. He also took a very active part in the Illinois State Academy of Science and served as President of that organization in 1931–32. He has been a Director of the Central States Forestry Congress since 1933 and of the Illinois Audubon Society since 1942. He was Editor of the Journal of Economic Entomology from 1936 to 1939, and a Vice-President of the Entomological Society of America in 1936.

Among entomologists he will always be remembered for his rejuvenation of the Insect Survey of Illinois. Definite plans for this were laid in 1927 and resulted in the beginning of a series of comprehensive reports on the biology, distribution and taxonomy of various groups of Illinois insects. In this series Dr. Frison published "The Fall and Winter Stoneflies of Illinois" (1929), "The Plant Lice of Illinois" (Hottes and Frison, 1931), "The Stoneflies of Illinois" (1935), and "Studies of North American Plecoptera, with Special Reference to Illinois" (1942). Dr. Frison envisaged the insect collection not only as a museum but as a storehouse of information to support biological and economic investigations over a broad field.

Dr. Frison died after about a year's illness and is survived by his wife, Ruby Dukes Frison, a son, Theodore Henry, Jr., and a daughter, Patricia Ann.

The entomological and biological fraternity has suffered a great loss in his passing.—H. H. Ross.

Joseph R. Watson, a member of the Society since 1913 and a Fellow since 1939, was born in Berea, Ohio, on August 1, 1874, and died in Gainesville, Florida, June 6, 1946, after a brief illness. He received the B.S. degree from Baldwin College in 1897 and the M.S. from Western Reserve, in 1899. He attended several summer sessions at the University of Chicago, beginning in 1903. He served as assistant and instructor in biology at Adelbert College of Western Reserve from 1899 to 1901. The following year he was instructor of botany, physics, and chemistry at Berea College, Kentucky. From 1903 to 1905 he was head of the Department of Science at Rochester College, Indiana, and the next year he taught biology in the Manitowoc, Wisconsin, high school. In 1907 he went to the University of New Mexico, where he served as professor of biology until 1911. In 1911 he moved

to Florida as head of the Department of Entomology of the Agricultural Experiment Station, succeeding his close friend, Dr. E. W. Berger, who that year was appointed State Nursery Inspector. He continued as head of the department until his death, and in point of continuous service, was the oldest member of the Experiment Station staff.

His principal interest was in the field of applied entomology as related to Florida agriculture. He did extensive work on the biology and control of the velvet bean caterpillar and the lubberly locust. Many insect pests of citrus and vegetable crops received his attention, and he was instrumental in finding better ways of combating them. He recognized the value of biological control and initiated the introduction of parasites and predators of several crop pests. His work on the control of rootknot nematodes won for him wide acclaim. He developed methods of combating this major crop pest which are standard practices on Florida farms.

In the field of systematic entomology, he was internationally known for his work on Thysanoptera. He described some 30 new species of thrips and built up a collection of these insects, containing nearly forty thousand slides. A bibliography of his papers on this group would contain at least 50 titles. He was the author of several Experiment Station bulletins and numerous papers in scientific journals and in magazines devoted to citrus and other crops. For the past 16 years he gave an average of 30 entomological talks a year on the Florida Farm Hour program of the University radio station, and hundreds of Florida farmers thus became acquainted with him and his work.

Professor Watson was a true lover of Nature. At every opportunity he would be found at some favored spot in field or wood to observe and enjoy and collect desirable specimens. The beauty of tree, or flower, or bird, touched him deeply and he always shared with others the joy and happiness that they created in his heart. He was active to within a few days of his death and on his microscopic stage he left a slide of an undescribed thrips which he was studying, and preparing to describe. A half-finished drawing of the same insect lay on the desk by the side of the microscope. He possessed a fine sense of humor and his friendly, kindly disposition endeared him to his associates and friends who will miss him greatly.

He was a Fellow of the American Association for the Advancement of Science, a charter member and past president of the Florida Entomological Society, and also a member of several other scientific and honorary societies.

On August 26, 1902, he married Miss Elizabeth Prout, who died in 1938. He is survived by three daughters, a brother, a sister, and four grandchildren.

—A. N. Tissot.

Dr. Grace H. Griswold, since 1918 a member of the staff of the Department of Entomology, Cornell University, and an authority on household insects, died the 22nd of January, 1946. Earlier in the winter a severe attack of influenza left her in a weakened condition, but in spite of this she returned to her work in the laboratory. On the day of her death she had lunch with some friends, apparently in her usual good spirits. Her sudden demise a few hours later therefore came as a great shock to her colleagues and many friends.

Miss Griswold was the daughter of the late Dr. Joseph B. Griswold, who for many years was a prominent physician in Grand Rapids, Michigan. She was born in Taylors Falls, Minnesota, December 14, 1872, but came to Grand Rapids with her parents the following year. While a resident of that city she was an enthusiastic gardener, was one of the founders of the Kent Garden Club and its first secretary. Upon the death of her father in 1915, she entered Cornell University as a student of Landscape Architecture, graduating in the fall of 1918.

Being aware of the many insects which infest the flower garden she turned her attention to the study of entomology, entered upon graduate work in the subject and received the degree of Doctor of Philosophy from Cornell University in 1925. She was appointed a research instructor in the Department of Entomology, making a special study of insects that attack ornamental plants and of those infesting the household. The results of her various studies have been published in several bulletins of the Cornell University Experiment Station and in articles which have appeared in entomological journals.

Although officially she retired in 1941 she continued regularly to spend several hours a day in the laboratory engaged in writing up the results of her experiments and in building up a collection of aphids injurious to ornamental plants. Beginning her entomological career much later than most, by her industry and enthusiasm she established an enviable reputation as an authority in her special field. Her published papers demonstrate in their form and substance the meticulous care with which they were prepared.

She spared no effort in being helpful to the women students in whom she took a strong personal interest. A woman of strong character, with firm convictions, and outspoken, she was kindly, friendly and co-operative.

She was a fellow of the American Association for the Advancement of Science and of the Entomological Society of America; a member of the Association of Economic Entomologists, and of the honorary societies Sigma Xi and Sigma Delta Epsilon.

By her death the members of the Department of Entomology have lost a faithful colleague, her associates a devoted friend, and the University a loyal supporter.—O. A. JOHANNSEN.

THOMAS JEFFERSON HEADLEE, a charter member of the Entomological Society of America, who retired on January 1, 1944, as head of the department of entomology at Rutgers University and the New Jersey Agricultural Experiment Station, died at the Muhlenberg Hospital, Plainfield, N. J., on June 14, 1946, at the age of 69. Dr. Headlee, who was well known to many entomologists throughout the country and especially those in the east, was born February 13, 1877, at Headlee, Indiana. He was the son of Josephus Headlee, farmer, and Ruann (Mattix) Headlee. He attended the Delphi (Indiana) High School and the Indiana State Normal School. From Indiana University he received his A.B., in 1903, and his A. M., in 1904, and from Cornell University his Ph.D., in 1906. From 1895 to 1900 he taught in the township grade schools; from 1900 to 1901 he was principal of the township high school, and from 1902 to 1904 he taught biology in the city high school. In 1904 he was a summer instructor at the Indiana Biological Station. For a short time, 1906–1907, he was assistant and later associate entomologist at the New Hampshire Agricultural Experiment Station. He then went to Manhattan, Kansas, as a successor to Prof. E. A. Popenoe, and became head of the department of entomology and zoology at the Kansas State Agricultural College, where he had charge of the entomological and regulatory work from 1907 to 1912. During this period he was professor of entomology and zoology at the Kansas State Agricultural College, entomologist of the Kansas State Experiment Station and state entomologist to the Kansas Entomological Commission.

On October 1, 1912, he succeeded Dr. John B. Smith as head of the department of entomology of Rutgers College and became professor of entomology in the college, entomologist of the New Jersey Agricultural Experiment Station, and State entomologist to the New Jersey State Board of Agriculture. These positions he held until his retirement, except for that of state entomologist, which was abolished on June 30, 1933. Upon coming to New Jersey Dr. Headlee's first interest was the mosquito problem, especially the field control, and in this activity and in the fields of organization and legislation, he worked unceasingly for many years. From 1913 to 1943 he was secretary of the New Jersey Mosquito Extermination Association and from 1944 to his death, secretary emeritus. In addition, from 1935 to 1939 he was president of the American Mosquito Control Association.

Dr. Headlee's work in economic entomology covered a wide field. In addition to his teaching and to his interest in mosquito control, it embraced the study and control of insects injurious to various field and orchard crops, the study of temperature in relation to insect development, the effect of the electrostatic field on insects, the development of mosquito traps, insecticides, the promotion of industrial fellowships, etc. He also initiated in 1918 research in cranberry problems and eventually this work developed into a separate department. He also carried on a study of the biology of sewage disposal and this, too, developed into a separate department in 1926.

When the Japanese beetle was discovered in New Jersey in 1916 and the gypsy moth in 1920, Dr. Headlee took an active part in planning work against these pests. He helped to organize the Northeastern Entomologists, which held their first

meeting in Philadelphia in July, 1920, and this organization later became the Eastern Branch of the American Association of Economic Entomologists.

Dr. Headlee kept in close touch with various organized interests in New Jersey and for many years attended nearly all meetings of entomologists, held in the east. In addition he participated in many field trips. Because of this, he was known personally to many workers in the field of entomology. In fact, he cultivated human relationships extensively, knowing that without such support, many control programs would fail. In addition to his research activities he was interested in quarantine and regulatory work for the control of bee disease and nursery and agricultural pests, both in New Jersey and the nation at large, and in many instances took an active part in formulating policies. From 1925 to 1936 he was president of the Eastern Plant Board and for a time served as vice-president of the National Plant Board. In 1935 he was awarded the Rutgers College bronze medal and in January, 1944, he was selected by the New Jersey State Board of Agriculture for their annual Citation for Distinguished Service to New Jersey agriculture. In 1929 he was elected president of the American Association of Economic Entomologists and served this organization capably in various capacities for several years.

From 1924 to 1926 Dr. Headlee was a representative of the National Research Council and president of the Council in 1929. He also belonged to the Phi Beta Kappa, Sigma Xi, Alpha Zeta, the Entomological Society of America (charter member), the American Association of Economic Entomologists, and its Eastern Branch, and was a fellow of the American Association for the Advancement of Science, and an honorary member of the Eastern Nurserymen's Association, the New Jersey State Horticulture Society, official entomologist of the Society of American Florists and Ornamental Horticulturists (1916), and for many years, a member of the committee on research of the American Cranberry Growers' Association. Following his retirement in 1944, the Thomas S. Headlee Fellowship Fund was started by friends and associates.

On October 11, 1903, Dr. Headlee married Blanche Ives, of Delphi, Indiana. Four daughters were born, Mary Ruanna, Miriam Esther, Ruth Margaret, and Josephine (dec.). At his death Dr. Headlee was survived by his wife, Mrs. Blanche Ives Headlee, and three daughters, Mrs. Floyd Markham of New York, Mrs. Carl Stover and Miss Ruth Headlee of Dayton, N. J., where Dr. Headlee lived and operated a 45-acre apple orchard. Funeral services for Dr. Headlee were held in Kirkpatrick Chapel of Rutgers University on June 17, 1946. Dr. Headlee was the author of approximately 300 papers, bulletins, reports, etc., on various aspects of his work. His last publication was a book on "The Mosquitoes of New Jersey and Their Control," published in 1945 by the Rutgers University Press. His death brought to a close an active, varied and successful career in economic entomology.—H. B. WEISS.

THE COMMITTEE ON BIOGRAPHIES.
H. B. WEISS,
J. S. WADE,
E. O. ESSIG, *Chairman*.

THE TAXONOMY AND BIONOMICS OF SOME PANAMANIAN TROMBIDIID MITES (Acarina)[1]

CHARLES D. MICHENER,[2]
American Museum of Natural History,
New York City

The principal purpose of this paper is to present information concerning the life histories of some species of mites from Panama. Incidentally, several species are described as new.[3] The need for knowledge of life histories, particularly for correlations of larvae and adults, is great in the Trombidiidae, because the great majority of the species and even of the genera are known from larvae only or adults only. Thus there are two nearly separate classifications, one for adults, the other for larvae.

CLASSIFICATION

The family Trombidiidae was divided by Thor (1935) into ten subfamilies, and this classification has been followed by Womersley (1937) and others. The species discussed in this paper all fall in the subfamilies Allothrombidiinae and Microtrombidiinae. The Trombiculinae are considered only in a comparative way in the section on life history, the detailed information concerning them having been presented in previous papers. Incidentally, it does not seem justifiable to recognize the latter group as a separate family as has recently been done (Ewing, 1944), especially when the other nine subfamilies are not also raised to family rank. It is far more logical to expand and enrich the classification by the use of subfamily and tribal names than by elevating each slightly distinct group to the family status.

Numerous genera have been described in the Microtrombidiinae, many of them based primarily on differences in the structure of the body hairs. Such differences are exceedingly striking, and in some instances doubtless offer good generic characters. However, some of the "genera" are merely unnatural assemblages of species. Obviously related species sometimes have very different body hairs and fall into different "genera." Thus, the species *pistiae* and *maculatum* described in this paper are clearly related, as shown by such characters as the

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[1]The cost of publishing this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

[2]Acknowledgment is made to the Gorgas Memorial Laboratory, Panama City, R. P., and especially to its director, Dr. Herbert C. Clark, for excellent facilities provided for this work.

The work described in this paper was done, in part, under a contract (recommended by the Committee on Medical Research) between the Office of Scientific Research and Development and the Gorgas Memorial Laboratory.

[3]Holotypes and allotypes of all new species will be placed in the collection of the American Museum of Natural History. Paratypes of each species will be deposited in the U. S. National Museum and the Museum of Comparative Zoology.

bidentate chelicerae of the larvae, the loss of one of the claws of the posterior legs of the larvae, the structure of the pedipalps and their claws in the larvae, the shape of the crista and associated structures in the adults, the presence of two accessory claws on the pedipalps of the adults, etc. Yet because the body hairs differ, these two species would fall in different genera in recent classifications. For the present, I have followed the example of Boshell and Kerr (1942) and described such species in *Microtrombidium*. At some later date, when more larvae and adults have been correlated, it will doubtless be possible to define natural genera.

There is a wide range of variation in some of the characters which have commonly been considered of value in distinguishing species. This is particularly true in species which grow and molt as adults. Thus in *Manriquia bequaerti* the number of setae in the basal comb of the pedipalpal tibia ranges from eight to thirty, and in *M. panamensis*, from four to twenty-one.

LIFE HISTORY

In order to clarify the use of the terms here employed to designate the various stages in the life cycle of these mites, a summary of the life history is here presented. The opportunity is taken to point out certain differences between the subfamilies which apply to all the species investigated in this study. When the stages of the life cycle are known for a greater number of genera and species, some of these differences may be shown to be subfamily characters.

The *eggs* are spherical, smooth or feebly roughened, laid in groups or masses in the Microtrombidiinae and Allothrombidiinae, and occasionally in the Trombiculinae, although they are more often laid singly in the latter subfamily. In one species (*Microtrombidium maculatum*) the eggs are laid in a mass in a matrix of a translucent gelatinous substance. Apparently there is a correlation between the size of the mite and the manner in which the eggs are laid. Thus it is the small species which lay eggs singly, middle sized species in small clusters, and large species in large masses. There may be several hundred eggs in the masses of *Allothrombium metae*, a large mite, reaching a length of 3.5 mm. The duration of the egg stage ranges from as little as four days (in *Microtrombidium pistiae*) to over two weeks (in *Manriquia bequaerti*).

Upon hatching, the chorion of the egg breaks more or less equally into two portions, and the next stage, the *deutovum*, becomes visible. The deutovum or prelarval stage is quiescent, without setae but often finely papillate, with six unsegmented immobile legs directed more or less forward and with one or occasionally two dorsal spines. In the subgenus *Megatrombicula* of the genus *Trombicula* there are several other spines on the deutovum. The posterior portion of the chorion or egg shell usually covers the posterior part of the deutovum, while the anterior portion remains over the anterior part of the deutovum, so that only the middle of the deutovum is exposed (Trombiculinae) or falls away leaving the entire anterior part of the deutovum exposed (Microtrombidiinae). The deutovum is considerably larger in size than the egg. It is possible that absorbed water accounts for this phenomenon.

Before the emergence of the larva the red pigment spots surrounding the larval eyes become visible through the integument of the deutovum. The larval appendages form within the unsegmented deutoval appendages. The coxae and trochanters of the larval legs are directed outward into three blunt lateral protuberances on each side of the deutovum; the remaining segments of the legs are directed from these protuberances downward and forward into the leg sheaths of the deutovum. For as much as three or four days, in some instances, before larval emergence, the legs of the larva may be seen moving back and forth within the leg sheaths of the deutovum.

The *larva* is an active, six-legged form, more or less sparsely setose. The larvae are parasitic, those of the Trombiculinae on vertebrates, those of the Microtrombidiinae and Allothrombidiinae on insects and spiders. After attaching themselves to their hosts by means of the chelicerae, they engorge, reaching a size varying from one and one-half (small *Eutrombicula*) to six (*Allothrombium*) times the length of the unengorged larvae. Engorgement apparently requires two or more days, larvae sometimes remaining attached to their hosts for over three weeks. The time until larvae leave the host is highly variable even among individuals of a single species. After engorgement the larvae drop from the host, walk about for a short time, and then become quiescent in a suitable hiding place. Among genera known from Panama, larvae of the Trombiculinae have a single dorsal plate while those of the other two subfamilies have two. This distinction applies in general to species from other areas of the world, but a few exceptions have been found.

After becoming quiescent, the integument of the *protonymph* or nymphochrysalis develops within that of the engorged larva. The protonymph is pupa-like and entirely quiescent, never emerging from within the larval integument, and as with other such stages, setae are absent. The protonymphal integument, however, is often exposed by breaks in the larval integument. In some species such breaks occur normally, exposing many parts of the protonymph. With the development of the protonymph, the larval appendages become dead and brittle, histolysis probably taking place within them. The appendages of the protonymph (in those groups which possess them) thus develop within the body of the larva. There are eight legs instead of six as in the larvae. The protonymphs of the three subfamilies here studied are conspicuously different from one another by the characters shown in Table I. The nymphal appendages develop within those of the protonymph in the Trombiculinae and Allothrombidiinae, and curl within the protonymphal sac (fig. 27) in the Microtrombidiinae.

The *nymph* is the first active eight legged stage. Like the adults, the nymphs are covered with numerous setae, usually branched and often thickened or curiously ornate. Nymphs of the Microtrombidiinae and Trombiculinae may be distinguished from adults by the presence of but four genital suckers, but in *Allothrombium* there are six in both nymphs and adults. The penal cone and sacculi (as they are called by Ewing, 1944a), characteristic of the genitalia of the adult males and females respectively, are absent in nymphs, the sexes being apparently indistinguishable. The setae on the body and appendages are sparser

than in adults and the number of coarse setae or spines on the pedipalps of nymphs is generally fewer. The more important taxonomic features of nymphs, however, such as the structure of the body hairs, the crista, the pseudostigmatic organs, the eyes, and the arrangement of combs, accessory claws, and the like on the pedipalps are not greatly different from those of the adults.

The nymphal stage is followed by another quiescent stage, the *preadult*. The preadult differs from the protonymph only in its larger size. After the formation of the preadult integument, the nymphal appendages become dry and brittle, and the preadult integument is frequently exposed by breaks in the old nymphal integument. The preadult, however, never emerges from the nymphal integument. The preadult (and hence adult) appendages do not form within those of the nymph, but are folded inside the body of the nymph. The relation of developing adult appendages to those of the preadult is the same as that of nymphal appendages to the protonymph.

TABLE I

CHARACTERISTICS OF THE PROTONYMPHS AND PREADULTS OF THREE SUBFAMILIES OF TROMBIDIIDAE

ALLOTHROMBIDIINAE	TROMBICULINAE	MICROTROMBIDIINAE
Appendages present; body fitting around appendages at rear, so that the appendages occupy a shallow concave space in venter of body; no dorsal spine, but a large longitudinal anterior dorsal groove; body surface not tuberculate but coarsely wrinkled.	Appendages present; body not fitting around them, the appendages projecting freely; anterior dorsal spine present, dorsal groove absent; body surface finely tuberculate.	Body saclike, without appendages, dorsal spine or groove; body surface often finely tuberculate.

The *adult* in the Microtrombidiinae and Trombiculinae may be recognized by the presence of six genital suckers. Other features which distinguish adults from nymphs are indicated above.

In certain species of Microtrombidiinae the adults continue to grow and molt. Each succeeding adult stadium is preceded by a quiescent stage not distinguishable from the preadult. For convenience the term preadult is applied to these stages, although actually they are between (not merely before) adult stages. Even among individuals of a single species the number of adult stadia is highly variable. Thus in ***Microtrombidium maculatum***, the best known species exhibiting adult growth, the number of adult stadia may probably vary from three to seven. Information on growth in this species is shown in Table VIII. Because the body integument stretches, body growth can take place between molts. For this reason, to get information on molts, measurements were made of the last segment of the anterior leg. Although no individuals were reared through, numerous lines on the graph indicate the amount of growth accomplished at one ecdysis. This information was obtained by comparing the measurements of exuviae with the mites which emerged from them. An examination of the graph shows that the amount of growth at one molt is highly variable, ranging from as little as 0.02 mm. to as much as 0.19 mm. in the length of the last

segment of the front leg. The largest adult measured was three times the size of the smallest.

The smaller adults, here termed ***subadults*** for convenience although no clear-cut distinction can be drawn between subadults and adults, differ from larger ones in having somewhat fewer setae, although they are approximately as dense as in larger individuals. For this reason the combs of the pedipalpal tibiae have fewer setae in small than in large specimens. Thus in ***Manriquia bequaerti***, which, like ***Microtrombidium maculatum***, grows considerably as an adult, the longer comb of the pedipalpal tibia has as few as eight setae in a small subadult, as many as thirty in a larger adult.

In some species in which there is adult growth, egg laying is observed only among females of middle size and above. The genital structures appear the same, however, in large and small individuals. For example, the smallest males have a penal cone structurally indistinguishable from the largest. Growth and molting continue after the egg laying size has been reached, and it is probable that females lay several masses of eggs during their lives. In other species (eg. ***Manriquia panamensis***) even small females produce eggs.

TABLE II

SUMMARY OF LIFE HISTORY OF TROMBID MITES

Major stages.....	egg		larva		nymph		adult
Intervening stages.....		deutovum		protonymph		preadult	

Even among rather closely related species, some may show adult growth and others not. Thus in ***Microtrombidium pistiae***, obviously related to ***M. maculatum***, there are normally no adult molts.

Females average somewhat larger than males in each species studied. The distinctions between the sexes of the ***Trombiculinae*** were pointed out (for ***Eutrombicula göldii***) by Boshell and Kerr (1942) and again, with illustrations, by Ewing (1944). In other subfamilies features distinguishing the sexes are about the same, except that the necks of the sacculi of the female are inconspicuous and the penal cone of the male is often turned on its side in mounting. Its several apodemes projecting into the body (figs. 29 and 30) are conspicuous.

Table II will serve as a summary of the life history. The nature of the intervening stages remains a matter of doubt. Probably they should not be considered as separate stadia. The integument of these stages consists in part of a cuticle, not affected by caustic, which is apparently laid down by a layer of epithelial cells (Henking, 1882). In these respects this integument resembles other arthropod integuments. However, the occurrence of such a stage between each major stage, regardless of the number of the latter in species molting as adults, suggests that the pupa-like quiescent stages are merely a part of the mechanism of ecdysis in this group.

ABNORMALITIES

Most of the variations observed, as for example in the number of coarse spines on the pedipalps, are considered to be within the limits of ordinary specific variation and are discussed separately under each species. A few very curious specimens have come to notice. In each case the specimens appear to be normal except for the peculiarities described.

One subadult of *Microtrombidium maculatum* was reared from a normal and apparently uninjured nymph. The subadult had the normal three genital suckers on the left side of the body, but two elongated ones on the right. The fourth leg was completely absent on the right side, the area where its coxa should have been being covered by bare and slightly tuberculate integument. The third leg on the same side was represented only by a small hairy projection about the size and shape of the distal half of the last tarsal segment, arising directly from the body without a coxa and bearing a pair of normal claws.

A nymph of the same species had a very small sucker behind the normal posterior genital sucker of one side. An adult had a very small sucker behind the median genital sucker of one side.

An adult of *Manriquia bequaerti* had four genital suckers of equal size on one side, making a total of seven. Another adult of the same species had a total of but four genital suckers, thus resembling a nymph, although the suckers were elongated.

An adult of *Manriquia panamensis* had two elongate suckers on one side, instead of the usual three. Another specimen had the posterior sucker of one side reduced to about one-fifth of the normal diameter.

TAXONOMY AND BIONOMICS

Allothrombium metae Boshell and Kerr

Allotrombidium metae Boshell and Kerr, 1942, Rev. Acad. Colombiana Cien. Exact., Físic. Nat. Vol. 5, p. 126.

Adults of this species, agreeing well with the original description and ranging from 2.6 to 3.5 mm. in length, were found at Old Panama, Panama, in January, February, March, October, November, and December. One was also taken near Pacora, Panama Province, Panama, and others at Santa Rosa, Colon Province, Panama, and Juan Mina, Canal Zone, Panama.

Egg: Yellow, smooth, spherical, laid in masses of several hundred.

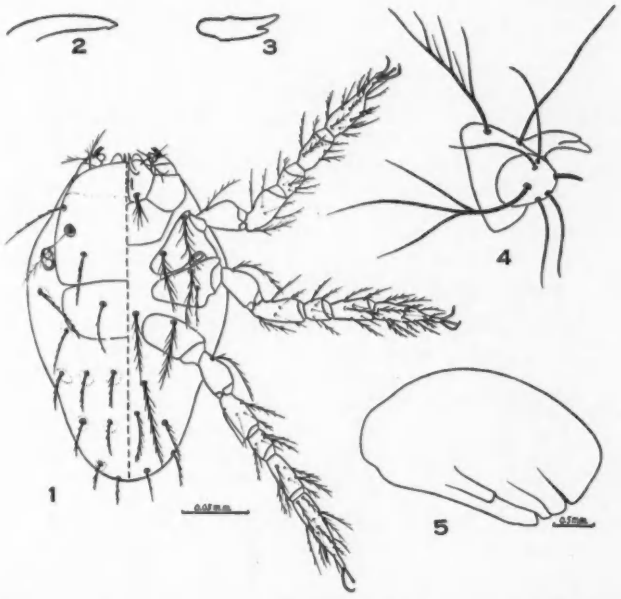
Deutovum: Dull yellow. Unfortunately none were preserved for study.

Larva: Length about 0.23 mm. when unengorged, color orange yellow; when fully engorged length 1.4 mm., color orange red. The characters are shown in the accompanying illustration. Anterior eyes commonly smaller than posterior.

Protonymph: Dull red; body surface coarsely and irregularly wrinkled, not tuberculate; leg sheaths closely appressed together and to

body; antero-dorsal portion of body with broad, deep longitudinal groove, corresponding to the groove in which the crista of the next stage lies.

Nymph: Length 1.5 mm. when freshly emerged to 2.5 mm. when ready to molt. Agreeing in general with adult, even having six genital suckers as in adult; last anterior tarsal segment little longer than tibia, instead of much longer as in adult.



Allothrombium metae Boshell and Kerr. 1, larva; 2, apex of chelicera of larva; 3, pedipalpal claw of larva; 4, apex of pedipalp of larva; 5, preadult.

Preadult: Distinguishable from protonymph only by size.

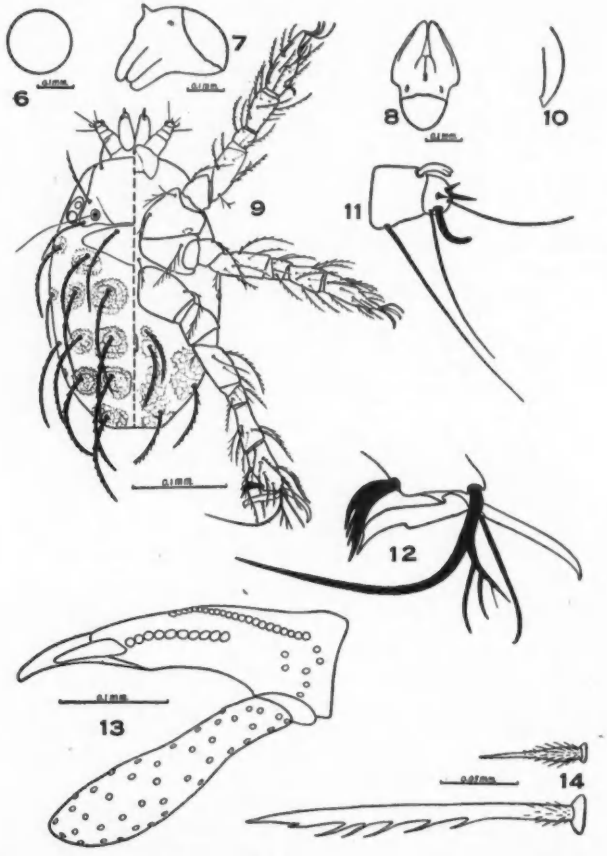
Bionomics: Nymphs and adults were usually found beneath stones, occasionally beneath logs. They are rather uncommon, and seem to disappear during the latter part of the dry season and early part of the wet season. Their movements are slow.

On January 15 at Juan Mina three very large engorged larvae were found attached to lycosid spiders of the genus *Pirata* (determined by Dr. Willis J. Gertsch). Each spider carried a single larva attached between the cephalothorax and the abdomen.

Egg masses were found beneath stones, and one was laid in the laboratory. The egg and deutoval stages are long, as larvae emerged

on May 8 from a mass laid before April 1. Two tremendously engorged larvae were found beneath a stone at Santa Rosa on November 14. Each soon became a protonymph, and three weeks later one was mounted and found to contain a nearly completely formed nymph. On December 12 after thirty days of quiescence, a nymph emerged from the other. These nymphs were similar to nymphs obtained in the field. A preadult was found beneath a stone on November 8.

From the relatively uniform size of the appendages of adults of this species it seems probable that there are no adult molts. Although this



Manriqua bequaerti Boshell and Kerr. 6, egg; 7, lateral view of deutovum; 8, dorsal view of deutovum; 9, larva; 10, apex of chelicera of larva; 11, apex of pedipalp of larva; 12, apex of posterior leg of larva; 13, inner view of tibia and tarsus of pedipalp of adult; 14, body hairs of adult.

is the largest of the mites studied, it attains its size, not by repeated molts as in the large Microtrombidiinae, but by great increase in size and stretching of the body integument during each active stage.

Manriquia bequaerti Boshell and Kerr

Manriquia bequaerti Boshell and Kerr, 1942, Rev. Acad. Colombiana Exact., Fisic. Nat. Vol. 5, p. 119.

Adults of this species from Panama differ from the original description of the species in being more often dull red than reddish brown, although a few specimens were of the latter color; and in having the fingers of the pedipalps slightly exceeding the claws, at least in large specimens. The combs of the tibia of the pedipalp do not both arise close to the base of the claw, as described for ***bequaerti***. One arises at the base of the accessory claw; another, more dorsal in position, arises some distance from the claw. Panamanian specimens were sent to Dr. H. E. Ewing for comparison with the types of ***bequaerti***. He found them to be the same, noting particularly that only one palpal comb arises close to the base of the claw, in contrast to the original description of ***bequaerti***. It may be noted that the setae of the basal (dorsal) comb are a little more slender, or at least have smaller bases, than those of the distal comb. The distal segment of the anterior tarsus varies in shape, but is usually more than twice as long as broad, contrary to the description of by Boshell and Kerr. Indeed the photograph given by these authors shows it more than twice as long as broad.

Adults were collected at Old Panama, Panama; near the landing at Barro Colorado Island, Canal Zone, Panama; and at Santa Rosa and Pina, Colon Province, Panama.

As with other species which grow and molt as adults there is great variation in size and in the number of bristles in the pedipalpal combs in *M. bequaerti*. Subadults have been collected which were only 0.77 mm. in length, while the largest adults were 2 4 mm. long. The variation in the number of bristles in the pedipalpal combs is in general correlated with size, but there is much variation in this matter, as shown in Table III. Here the numbers of bristles in the combs and the length of the last segment of the foreleg are shown for certain specimens selected to demonstrate the extent of the variation. There is frequently a difference of one or two in the number of bristles in the combs of the two pedipalps of a single individual. When the setae of both pedipalps could be accurately counted and a difference was noted, it is indicated by a double entry in the columns of this table.

Usually but not always there are two large simple bristles basad of the large spine on the outer side of the tibia of the pedipalp. Sometimes there is but one such bristle, and in one specimen a bristle was present on one side, absent on the other.

There is noticeable variation also, not correlated with size or number of setae in the combs, in the body hairs. The larger hairs are often longer and more slender than in the figure. Large hairs which are not at all swollen at the base lack the small setulae shown in the figure, but those which are slightly swollen have such setulae. Occasionally a

specimen is found having a few small setulae throughout the length of the large hairs. The number of large teeth on the large hairs varies from two or three to over ten. Small hairs are sometimes setulose to the apices.

All these variations have been observed in specimens collected at Old Panama at the same time under the same group of rocks.

Egg: Orange, smooth, spherical, averaging about 0.18 mm. in diameter, laid in masses of 50 to 100. On breaking, anterior portion of shell falls completely away, the posterior remains around the posterior portion of the deutovum.

Deutovum: Orange red with single dorsal spine; body surface with scattered fine sharp papillae.

Larva: Length about 0.29 mm. when unengorged. Color red. The characters are shown in the accompanying illustration.

TABLE III

NUMBERS OF SETAE IN PEDIPALPAL COMBS AND LENGTH OF LAST ANTERIOR TARSAL SEGMENT IN SELECTED ADULT SPECIMENS OF *Mantiquia bequaerti*

Setae in Basal Comb	Setae in Distal Comb	Length (mm.) of Last Anterior Tarsal Segment	
24	14–13	.77	Largest specimen
10	6	.27	Smallest specimen
30–29 8	16 6	.66 .29	Longest and shortest basal combs
26 22 9	17–16 17 5	.74 .63 .29	Longest and shortest distal combs
12–11 21 15	9 14 10	.33 .55 .45	Combs not greatly different in length
13 20 26	7 10 13–15	.40 .59 .66	Combs of widely different lengths

There are several differences between the larva and the description of Boshell and Kerr. They state, for example, that the second dorsal plate has four setae, while it has but two in Panamanian specimens. These differences are evidently more apparent than real, however, since their material was evidently poor. The extra pair of setae which they describe as arising from the second dorsal plate is present, but does not arise from the plate.

The inner hair of the anterior coxa is often trifid instead of bifid as shown. In one "freak" larva studied there are three instead of two midventral abdominal hairs on one side, and on the same side of the body there is an extra antero-lateral seta on the anterior dorsal plate.

Protonymph: Unknown.

Nymph: Length 0.52–0.77 mm. Agreeing with the adult except for the usual nymphal features. Basal comb of pedipalps with four to five bristles, distal with four; body hairs noticeably sparser than in adults.

Preadult: Sac-like, surface practically smooth. Color red.

Bionomics: All stages of this mite have been collected beneath stones, and an occasional individual has been found beneath a log or in leaf mold. It is the most common trombidiid beneath stones among the ruins of Old Panama, although not much more abundant than *M. panamensis*. Adults of all sizes have been found at all seasons of the year, although at Old Panama specimens were very difficult to find during the last of the dry season and first part of the rainy season (May to July). The few nymphs obtained were found in August and October, eggs in May and August. Although long-legged, these mites are usually very sluggish in their movements.

Egg masses have been found under stones in the field, and have been laid in the soil in a rearing jar in the laboratory. The meagre information available on the duration of the egg and deutoval stages is as follows: eggs found in field on May 12, 1945, were in deutoval stage by May 20, larvae emerged May 30 to June 3; eggs laid in the laboratory on May 30 reached the deutoval stage about June 14 and larvae emerged June 26 to 28.

There is no information on the duration of the other stages, except that field collected preadults have remained in that stage for as much as fourteen days before transforming.

In this species there are several adult molts. Table IV, in which the length of the last anterior tarsal segment is used as an index of size and lines indicate the growth of certain individuals at one molt, shows all available data on growth. Unlike *M. panamensis*, egg laying probably does not begin until the females reach middle size. At each molt, there is an increase in size as well as in number of bristles of the pedipalpal combs. The amount of increase in size is well correlated with the number of additional bristles acquired. Thus in two cases in which the amount of growth of the last anterior tarsal segment was 0.04 mm. at a molt there was only one seta added to each pedipalpal comb. On the other hand, in one specimen in which the amount of growth was 0.16 mm. there were four bristles added to the distal comb and five to the basal comb.

Manriquia panamensis n. sp.

Adult: A moderate sized red species with body hairs of two types, both pointed at tips, the larger type with branches of one side thickened and dense distally giving each hair a club-like appearance at low magnifications.

Length 1.5 mm. (varying from 0.8 to 1.8 mm. among paratypes).

Pedipalps reaching to middle (or apex) of patella of foreleg; claw less than half as long as distal process of chelicera (more than half as long in some paratypes); outer side of tibia with a slender spine[4] varying from two-thirds as long to as long as claw and arising about midway between base of claw and base of finger; inner side of tibia with an accessory claw half as long as principal claw, and two combs of bristles,

[4]The thickness of this spine varies. It is rather unusually long and slender in figure 16. Sometimes it is entirely lacking; in other specimens it is preceded by two small spines or by two large ones so that there is a row of three spines, the basal one above the base of the finger.

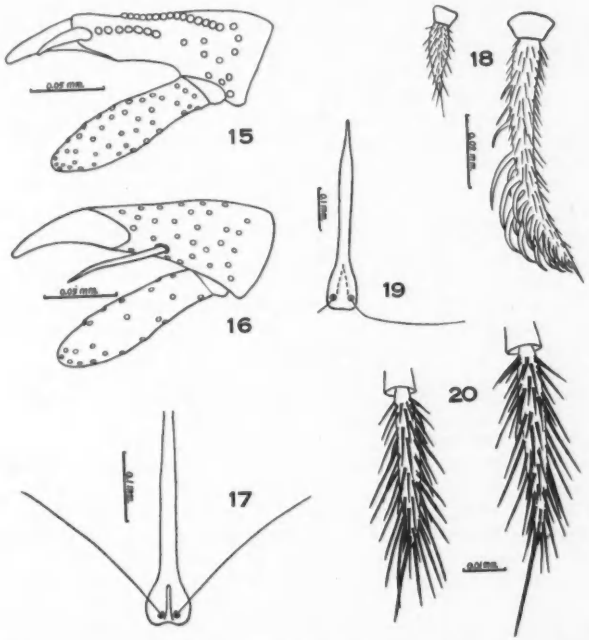
TABLE IV

Manriquia bequaerti
FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N = nymphs, M = adult males, F = adult females. Figures under "eggs" show the number of individuals in each size class which laid or contained eggs. Lines under "growth of individuals" show the amount of growth at one molt of certain individual mites.

	N	M	F	Eggs	GROWTH OF INDIVIDUALS	
					Males	Females
.19–.20	1					
.21–.22	2					
.23–.24						
.25–.26						
.27–.28		1	2			
.29–.30		2	2			
.31–.32						
.33–.34		2	2			
.35–.36		3				
.37–.38		2	2			
.39–.40		2	1			
.41–.42		1	3			
.43–.44		8	1			
.45–.46		2	1			
.47–.48		1	4			
.49–.50		6	4			
.51–.52		2	1			
.53–.54		3	1	1		
.55–.56		5	4	2		
.57–.58		3	1			
.59–.60		2	3			
.61–.62		3				
.63–.64		3	1			
.65–.66		1	5	1		
.67–.68			1			
.69–.70			3			
.71–.72						
.73–.74			1			
.75–.76						
.77–.78			1			

the distal one of about seven (three to thirteen in adult paratypes of various sizes) bristles extending from the middle of the segment to the accessory claw, the basal (or upper) one of about sixteen (four to twenty-one in adult paratypes of various sizes) bristles extending from the end of the first fourth of the segment to the end of the third fourth; bristles of distal comb scarcely larger than those of basal comb; finger reaching apex of claw, its setae and most of those of outer side of tibia plumose. *Chelicerae* with distal process sickle-shaped, sharply pointed apically, the



Manriquia panamensis Michener. 15, inner view of tibia and tarsus of pedipalp of adult; 16, outer view of same; 17, crista of adult; 18, body hairs of adult.
Manriquia boshelli Michener. 19, crista of adult; 20, body hairs of adult.

concave margin minutely dentate. *Crista* rod-like, expanded posteriorly into a rounded pseudostigmatic area somewhat wider than long; pseudostigmatic organs simple, arising from cup-like depressions with sharp elevated margins in posterior lateral positions of pseudostigmatic area. *Eyes* sessile, posterior ones much smaller than anterior. *Body hairs* dorsally of two types; larger type more abundant posteriorly than anteriorly, arising from short thick papillae which are much broader basally than apically, main axis of hair curved, thickest near base, tapering near apex to slender sharp point (which in some specimens does not project beyond setulae as in figure 18); main axis covered on

concave side and base of convex side with numerous small hairlike setulae, remainder of convex side with numerous thickened curved setulae which often give entire hair a club-like aspect; smaller type of dorsal hair arising from papillae similar in shape to those of larger hairs, main axis much thickened but tapering to a sharp point and covered with numerous small setulae; venter anteriorly and around genital opening with rather elongate hairs of the small type, posteriorly with large type in addition; area anterior and lateral to eyes with slender hairs of the small type only. *Legs* (also basal halves of pedipalps) with hairs, particularly of upper surfaces, similar to larger type of body hairs, those of inner surfaces of appendages and distal segments being more slender and less curved than body hairs; first and fourth pairs of legs subequal in length and slightly longer than body, other pairs shorter than body; forelegs with femur longer than patella, scarcely longer than tibia, slightly shorter than basitarsus and much shorter than the dilated distitarsus, claws about two-thirds the size of those of other legs; second and third legs each with femur slightly longer than patella, slightly shorter than or subequal to tibia, and scarcely two-thirds length of each of the tarsal segments; fourth legs with femur, patella, and tibia subequal, tarsal segments longer, equal to each other (or the first a little longer than the second).

Holotype male: Old Panama, Panama, January 10, 1945, under stone (C. D. Michener). *Allotype* female and eighty-three *paratypes* from the same locality dated January 10, March 1 and 5, May 29, August 16 and 30, October 5, and November 10, 1945. This is a very common species at Old Panama. Additional specimens are from Chiva Chiva, Juan Mina, and Barro Colorado Island, Canal Zone, Panama; Santa Rosa and Pina, Colon Province, Panama; and three miles southwest of Arraijan, Panama Province, Panama.

Since adult growth occurs in this species, there is great variation in size of adults, the smallest subadults being only 0.7 mm. in length. Associated with the variation in size is variation in the numbers of setae in the combs of the pedipalps. In general, the smaller the specimen the fewer the setae in these combs, but there is great variation in this correlation, as shown in Table V, in which data on specimens showing extreme conditions of various sorts is presented, to give an idea of the extremes of the variation. The number of setae on combs of the two sides of the body frequently varies by one or two, very rarely more. When such variation was noted it is shown in this table.

Among specimens from localities other than Old Panama, there is some variation in the structure of the larger body hairs. These hairs are more slender apically in some, with the larger setulae more slender than in figure 18.

This species appears to be most closely related to *M. manriquei* Boshell and Kerr but differs, apparently, by the relatively longer fingers of the pedipalps, the usually fewer bristles in the combs of the pedipalpal tibiae, the presence of fine setulae on the concave sides of the large body hairs, and the more slender legs. In the figure of *M. manriquei* the last tarsal segment of the second, third, and fourth pairs of legs is clearly more slender than the next to the last segment, while they are of equal width in *panamensis*. The species is also evidently

TABLE V

NUMBERS OF SETAE IN PEDIPALPAL COMBS AND LENGTH OF LAST ANTERIOR TARSAL SEGMENT IN SELECTED ADULT SPECIMENS OF *Manriquia panamensis*

Setae in Basal Comb	Setae in Distal Comb	Length (mm.) of Last Anterior Tarsal Segment	
16	6-7	.44	Largest specimen
4	3	.18	Smallest specimen
17-21 20 4	13 7 3	.33 .41 .18	Longest and shortest basal combs
17-21 4	13 3	.33 .18	Longest and shortest distal combs
9 11 9	9 9 7	.35 .33 .24	Combs equal or nearly so
5-6 9 13	5 4 8	.22 .22 .25	Specimens of small size

TABLE VI

Manriquia panamensis

FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N = nymphs, M = adult males, F = adult females. Figures under "eggs" show the number of individuals of each size class which contained eggs. Line under "growth of individual" shows the amount of growth of one female at one molt.

	N	M	F	Eggs	Growth of Individual	
.15-.16	1					
.17-.18	1	1				
.19-.20						
.21-.22		1	2			
.23-.24		1				
.25-.26		3	3	1		
.27-.28		2				
.29-.30		3	3			
.31-.32		5	1			
.33-.34		11	4	1		
.25-.26		6	2			
.37-.38		3	5			
.39-.40		5	9			
.41-.42			2			
.43-.44			2	1		

related to the European *Microtrombidium sardoum* Berlese, and to the American *Microtrombidium modestum* Berlese, both of which should apparently be placed in *Manriquia*.

Egg: Similar to that of *M. bequaerti*, about 0.18 mm. in diameter. The eggs are probably laid in clusters as a number of eggs have been found within the body of a single mite.

Deutovum: Unknown.

Larva: Apparently indistinguishable from that of *M. bequaerti*. On June 24, 1945, larvae were found in a culture jar which had contained adults of this species for slightly over a month.

Protonymph: Unknown.

Nymph: Length 0.7 mm. Agreeing with description and figures of adult except as follows: Basal comb of tibia of pedipalp with four to six setae, distal comb of three to five; crista with an internal projection extending behind pseudostigmatic area, just as in both adults and nymphs of *Microtrombidium maculatum* and *pistiae*, body hairs rather sparse, larger type somewhat less thickened and thickened hairs of appendages more slender than those of adults.

Preadult: Saclike. Color red.

Bionomics: This species has been found under stones, under logs, in rotten logs, inside of a hollow tree several feet above the ground, in leaf mold and among the roots of grasses. Small as well as large individuals have been found at all seasons of the year, but at Old Panama, where it occurs chiefly under stones, this species became scarce during the latter part of the dry season of 1945.

Table VI shows that the adult growth is similar to that of *Microtrombidium maculatum* and *Manriquia bequaerti*. The most striking feature is that eggs are evidently laid by relatively small females.

Manriquia boshelli n. sp.

Adult: A moderate sized red species with body hairs essentially of a single type, pointed apically and densely plumose.

Length 1.5 mm. (varying from 1.0 to 2.1 mm. among the paratypes).

Pedipalps reaching to apex (or middle) of patella of front leg; principal claw more than half as long as process of chelicera; tibia with slender spine about as long as claw arising on outer side near base of finger; inner side of tibia with accessory claw half as long as principal claw and with two combs of bristles, the distal one of eleven (varying from six to twelve among paratypes) bristles extending from near middle of segment to accessory claw, the basal (upper) one of eighteen (ten to twenty-four among paratypes) bristles with its basal and distinctly nearer to base of segment than distal end is to apex of segment; bristles of distal comb coarser, having larger bases, than those of basal comb; setae of inner side of tibiae which are not in combs are unusually long and coarse, unbranched; finger slightly exceeding claw, parallel-sided, its setae and those of outer side of tibia plumose. (Apex of pedipalp about as figured for *M. bequaerti* except for the larger claw and parallel-sided finger.) *Chelicerae* with process sickle-shaped, sharply pointed, the concave margin minutely denticulate. *Crista* thick, rod-like, expanded posteriorly into a pseudostigmatic area which is longer than wide,

rounded posteriorly; pseudostigmatic organs simple. *Eyes* sessile, posterior ones slightly smaller than anterior. *Body hairs* arising from short subcylindrical papillae which are slightly wider distally than basally (or in small specimens slightly wider basally than distally); body hairs densely plumose, the main axes slightly thickened, apices sharply pointed; posterior portion of body with an intermixture of similar but slightly shorter hairs, lacking the slender free apex (figure 20). *Genitalia* with longer apodemes of penal cone fully as long as cone. *Legs* and most of pedipalps covered with a mixture of slender plumose and slender simple hairs none of them thickened like the body hairs although some of the plumose hairs are slightly thickened near bases; fourth pair of legs longest, first slightly shorter and about as long as body, second and third considerably shorter; forelegs with femur longer than patella, equal to tibia, slightly shorter than basitarsus, much shorter than the dilated distitarsus, claws about two-thirds the size of those of

TABLE VII

NUMBERS OF SETAE IN PEDIPALPAL COMBS AND LENGTH OF LAST ANTERIOR TARSAL SEGMENT IN SELECTED ADULT SPECIMENS OF *Manriquia boshelli*

Setae in Basal Comb	Setae in Distal Comb	Length (mm.) of Last Anterior Tarsal Segment	
22	12	.51	Largest specimen
11	7	.29	Smallest specimen
24 10	12 7	.44 .33	Longest and shortest basal combs
21 15	12 6–7	.48 .33	Longest and shortest distal combs
14 15–16	10 12–7	.39 .47	Combs not greatly different in length
20	9	.44	Combs of widely different lengths

other legs; second and third legs with femora and following segments progressively increasing in length; fourth legs thick except for the rather slender distitarsi, patella the thickest segment, trochanter swollen, femur, patella, tibia, and basitarsus progressively longer, distitarsus as long as tibia; pits from which hairs arise on fourth legs unusually large, so that seen in profile the margins of the segments appear dentate.

Holotype male, *allotype* female and four *paratypes*: Old Panama, Panama, August 16, 1945, under stone. Two paratypes, same locality, October 5 and November 8, 1945. Seven paratypes, Santa Rosa, Colon Province, Panama, September 10, 1945. Additional specimens are from Juan Mina, Canal Zone, Panama (R. Melvin).

The great variation in adult size of this species indicates that, as in other species of *Manriquia* studied, there is adult growth. Table VII shows, for certain selected individuals, the length of the last segment of the foreleg and the number of bristles in the pedipalpal combs.

This species seems to be related to *M. bolivarensis* Boshell and Kerr and *M. rocae* Boshell and Kerr. It differs from both in the thickened

body hairs with numerous branches and in the elongate pseudostigmatic area. It differs further from *M. rocae* in the larger posterior legs, and from *M. bolivarensis* in the longer pedipalpal claws.

Egg: Red, smooth, spherical, 0.16 to 0.19 mm. in diameter, probably laid in masses since one female collected August 16, 1945, contained 71 eggs.

Deutovum: Unknown.

Larva: Unknown.

Protonymph: Unknown.

Nymph: Length 0.9 mm. Agreeing with description of adult except for the usual nymphal characteristics. Distal comb of pedipalpal tibia with five to six bristles, basal with seven; body hairs sparser than in adult, their papillae slightly wider basally than distally.

Preadult: Unknown.

Bionomics: This species has been found under stones, under logs, and in rotting logs. It is much less common than either *M. bequaerti* or *panamensis*. Because of the variability of adults, it is quite certain that adult molts occur in this species, although none have been observed.

One adult remained alive in a rearing jar containing a small amount of earth for six months.

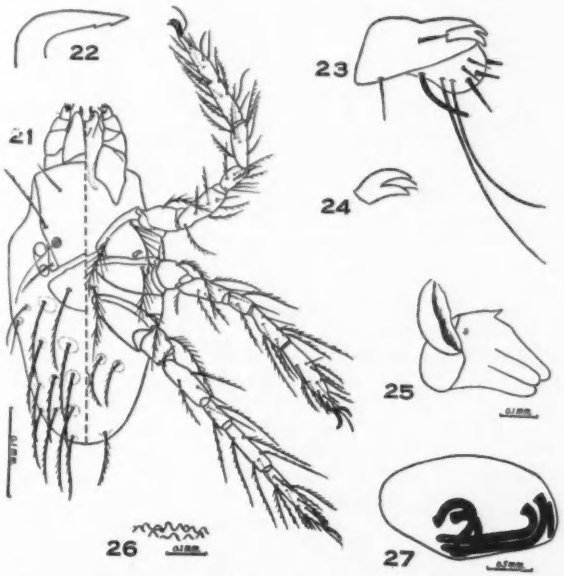
Microtrombidium maculatum n. sp.

Adult: This is a large red species, with small, somewhat diffuse, whitish spots produced by white hairs on the dorsal surface, these consisting of four transverse rows of three spots each, the foremost just behind the pseudostigmatic area, and behind these rows two pairs of spots. There are also white hairs at the posterior end of the body, on the venter, and on the legs. In cleared and stained specimens these spots are not visible. On each side of the principal claw of the pedipalp is a heavy spine or accessory claw, so that the pedipalp appears to be three-clawed.

Length 2.2 mm. (varying from 1.5 to 2.75 mm. among the paratypes).

Pedipalps reaching to apex of femur or middle of the patella of the anterior leg, depending on how much they are straightened in mounting; principal claw less than half as long as distal process of chelicera, on either side of principal claw is an accessory claw more than half as long as principal claw, that on outer side farther from principal claw than that on inner side; setae of inner side of tibia simple, numerous, those of distal half arranged in a comb reaching nearly to base of inner accessory claw, the comb becoming irregular basally so that it is difficult to determine where it stops; distal setae of comb progressively shortened and thickened, the terminal one about as long as (or shorter than) accessory claw; above this comb is a second and much shorter comb (sometimes so irregular as to be unrecognizable); finger approximately parallel sided (or slightly tapering), not quite reaching apex of claw, its hairs and those of outer side of claw-bearing segment finely plumose. *Chelicerae* with distal process broad, sickle-shaped, acutely pointed, with fine teeth on concave margin. *Crista* rod-like, with an internal projection extending a short distance behind pseudostigmatic area, the latter triangular, truncate behind; pseudostigmatic organs simple,

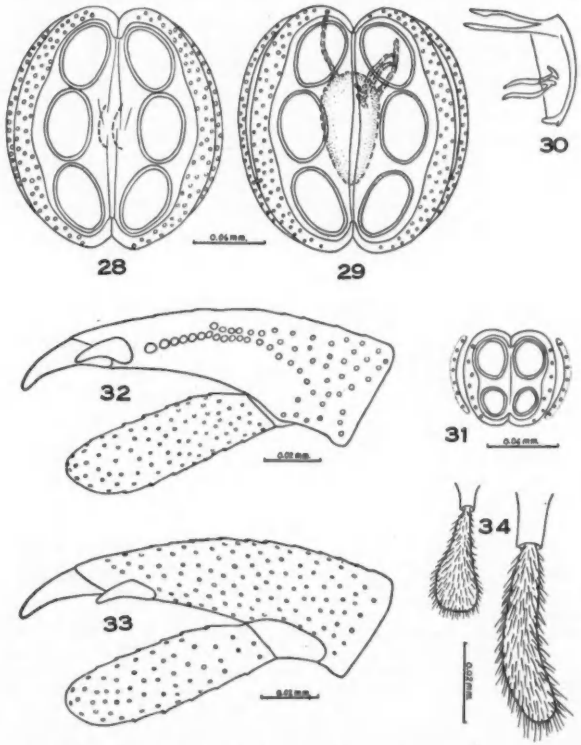
arising from posterior lateral corners of pseudostigmatic area; crista not consistently different from that of ***pistiae***, but rod-like portion anterior to pseudostigmatic area often narrower than figured for that species, and sometimes expanding gradually into the pseudostigmatic area. ***Eyes*** elevated, sessile, in the usual position above anterior coxae, the anterior ones much larger than the posterior (which are sometimes inconspicuous or virtually absent). ***Body hairs*** dense, those of dorsum and sides of two sizes, arising from large elongate papillae which are widest basally, the hairs thickened, rounded apically, widest subapically,



Microtrombidium maculatum Michener. 21, larva; 22, apex of chelicera of larva; 23, apex of pedipalp of larva; 24, claw of pedipalp of larva; 25, deutovum and broken egg shell; 26, surface sculpture of preadult; 27, preadult, showing diagramatically the manner in which the adult legs are developed within.

curved, and covered with many fine setulae; hairs of venter, except marginally, of a single size, arising from smaller papillae, the hairs thickest subbasally (or medially) and tapering to a pointed apex, covered with numerous setulae. ***Genitalia*** with apodemes of penal cone of male shorter than cone. ***Legs*** with hairs but slightly thickened, pointed, plumose; fore and hind legs slightly longer than body, other pairs shorter; fore legs with femur, patella, tibia, and second tarsal segment subequal, first tarsal segment slightly longer, second tarsal segment somewhat swollen, about three times as long as broad, its claws about three-fourths the size of those of other legs; proportions of segments of other legs approximately as in *M. pistiae*.

Holotype female, *allotype* male, and sixteen *paratypes*: Juan Mina, Canal Zone, Panama, June 10, 1945. One hundred and eighty-one additional paratypes from the same locality, March 15, August 23, September 12, and October 17, 1945. All were collected by the author in company with *M. pistiae* on the undersides of leaves of floating plants of *Pistia stratiotes*. Additional specimens were collected from a roadside ditch near Juan Diaz, Panama Province, Panama (R. Melvin).



Microtrombidium maculatum Michener. 28, genital area of adult female; 29, genital area of adult male; 30, lateral view of penal cone of adult male; 31, genital area of nymph; 32, inner view of tibia and tarsus of pedipalp of adult; 33, outer view of same; 34, body hairs of adult.

Since adult growth occurs in this species there is great variation in the size of adults and subadults. Subadults have been collected as small as .85 mm. in length. Structurally they are similar to large adults. Since there are fewer setae on small individuals the pedipalpal combs contain fewer setae, the longer comb having as few as eight in

some individuals. The principal claw of the pedipalp in small subadults is more than half as long as the distal process of the chelicera.

This species resembles *M. arborealis* Boshell and Kerr in some respects. That species, however, has two long combs on the tibia of the pedipalp, greater differentiation of the two sizes of body hairs and greatly modified posterior legs. In both larval and adult characters *maculatum* is related to *pistiae*, from which it differs most obviously in the nature of the body hairs. *M. maculatum* may be related to *M. 13-maculatum* Berlese, but the latter apparently lacks the inner accessory claw of the pedipalp.

Egg: Bright red, smooth, spherical, about 0.17 mm. in diameter, laid in masses of 120 to 200, enveloped in a translucent gelatinous material, unlike anything observed with other Trombidiidae. The chorion, on breaking, does not usually separate into two completely separate portions (see figure 4).

Deutovum: Similar to that of *M. pistiae*, having two dorsal spines, but the leg sheaths shorter than in that species; surface finely papillate in some areas.

Larva: Length 0.32 mm. when unengorged; when engorged up to 0.66 mm. Color red. The characters of the larvae are shown in the accompanying illustration. The pedipalpal claw often appears bilobed instead of trifid because of the curvature of the claw.

Protonymph: Saclike, finely tuberculate. Color red.

Nymph: Length 0.65 to 1.1 mm. Agreeing with the description and figures of adult except as follows: principal claw of pedipalp considerably more than half as long as process of chelicera; finger of pedipalp tapering toward blunt apex, considerably exceeded by claw; combs of pedipalpal tibia shorter, becoming irregular basally like those of adult so that it is difficult to state the number of setae; upper comb usually unrecognizable, consisting of one or two setae, longer lower comb consisting of four to seven setae; genital area with but two pairs of suckers; body hairs as in the adult but much sparser; legs with proportions of segments different from the adult, the two tarsal segments of the posterior leg being subequal.

Preadult: Differs from protonymph only in larger size.

Bionomics: Except for an occasional stray individual on other species of aquatic plants, nymphs and adults of this mite have been found only on floating plants of water lettuce, *Pistia stratiotes*. In sloughs along the Chagres River near Juan Mina, Panama Canal Zone, this plant sometimes forms dense patches in which *M. maculatum* is abundant and even conspicuous. Although this and other *Pistia*-inhabiting mites were found in numerous localities near Juan Mina, the most favorable of these places was in the Rio Hondo, a tributary of the Chagres just outside the Canal Zone boundary. The under surface of the thick, spongy *Pistia* leaves are coarsely ribbed or grooved and provided with numerous large hairs, and at the bases of several of the grooves are deep pits in the leaves of large plants. Except for the parasitic larval stage, this mite apparently normally spends its entire life in the protection of the grooves and pits of the *Pistia* leaves.

Although rather sluggish in its movements, these mites are able to walk easily on the water surface when disturbed. They quickly retreat

to *Pistia* leaves, however, if necessary pushing their way under water to get beneath the margins of the leaves. The mites do not get wet, their bodies being strongly hydrophobic.

All stages of the development of this mite have been found in practically every month of the year. The only obvious effect of the season on the abundance of the species results from the influence of varying water levels on the abundance of *Pistia*.

The large egg masses, enveloped in a translucent gelatinous material, are placed in grooves on the under sides of *Pistia* leaves. Eggs laid in the laboratory required at least eight days for the deutovum to appear. When the deutovum appears the egg shell breaks into anterior and posterior portions, but instead of becoming entirely separate, the anterior portion usually remains narrowly attached to the posterior at one side (see fig. 25). The deutoval stage, six to nine days in duration, is passed in the gelatinous matrix in which the eggs are imbedded.

The larvae, after working their way out of the gelatinous mass surrounding the eggs, crawl around actively on the *Pistia* leaves and on the water surface. Some individuals remained alive without feeding for thirty days, walking about on the surface of water in a jar. Most, however, died in a shorter period of time.

Engorged larvae have been found attached to mosquitoes (*Mansonia titillans* (Walker) and *M. nigricans* (Coquillett)) collected at Gatuncillo, Colon Province, Panama, by H. Trapido, as well as at Juan Mina. Most of the mites found on mosquitoes at these localities, however, were not trombidiids. The larvae of *M. titillans* at least are frequent on the roots of *Pistia*. On the mosquitoes, the mite larvae attach themselves to the intersclerotic membranes, for example, the cervical membrane, the membranes at the bases of the coxae, and less frequently the abdominal membranes.

Larval mites did not attach to *Anopheles albimanus* Wiedemann when adults of this mosquito were put in jars with the mites nor when adults emerged from pupae placed in a jar of water on the surface of which were many mites.

After engorgement the larva leaves its host, and engorged larvae are occasionally found on *Pistia* plants. The quiescent protonymph stage is apparently usually passed in a protected place on the under surface of a *Pistia* leaf. The duration of this stage is unknown but nymphs did not emerge from field collected protonymphs for as much as five days after the time of collection.

The duration of the nymphal stage is unknown. The quiescent preadult stages apparently have a duration of about ten days.

This species is characterized by a varying but relatively large number (probably two to six) of adult molts. Table VIII, using the length of the last segment of the foreleg as an index of size, and indicating by lines the differences in size between particular exuviae and the mites emerged from them, shows all the available information concerning growth. It is evident that the amount of growth occurring at the time of ecdysis is highly variable, and also that molting may take place after the egg laying size is reached. This last is emphasized by a gravid female, collected while quiescent, and with a preadult integument clearly developing around her internal organs and eggs.

Adults which have freshly emerged from the preceding preadult stage appear dark red and wet. The white spots are not visible until the body hairs dry.

TABLE VIII

Microtrombidium maculatum

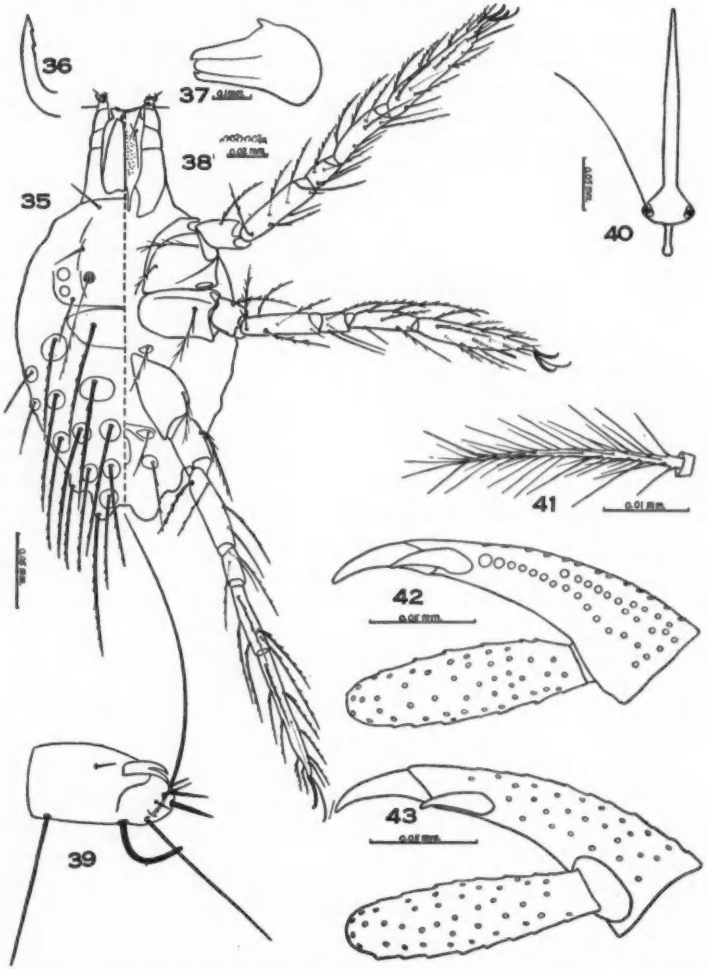
FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N = nymphs, M = adult males, F = adult females. Figures under "eggs" show the number of individuals in each size class which laid or contained eggs. Lines under "growth of individuals" show the amount of growth at one molt of certain individual mites.

	N	M	F	Eggs	GROWTH OF INDIVIDUALS	
					Males	Females
.13–.14	1					
.15–.16	11					
.17–.18	11					
.19–.20	2					
.21–.22		8	1			
.23–.24		6	1			
.25–.26		2	5			
.27–.28		6	4			
.29–.30		5	5			
.31–.32		1	2			
.33–.34		9	7			
.35–.36		3	2			
.37–.38		6	6			
.39–.40		16	11			
.41–.42		8	8			
.43–.44		16	10			
.45–.46		4	1			
.47–.48		5	7	2		
.49–.50		2	9	5		
.51–.52			10	3		
.53–.54		4	5	1		
.55–.56			13	6		
.57–.58			4	2		
.59–.60			5	1		
.61–.62			3	1		
.63–.64						
.65–.66			1	1		

Microtrombidium pistiae n. sp.

Adult: A rather small red or brownish-red, or occasionally brown, species with body hairs of a single type, unthickened and plumose. On each side of the principal claw of the pedipalp is a heavy spine, so that the pedipalp appears to be three-clawed.



Microtrombidium pistiae Michener. 35, larva; 36, apex of chelicera of larva; 37, deutovum; 38, surface sculpture of deutovum; 39, apex of pedipalp of larva; 40, crista of adult; 41, body hairs of adult; 42, inner view of tibia and tarsus of pedipalp of adult; 43, outer view of same.

Length 1.0 mm. (varying from 0.8 mm. to 1.5 mm. among the paratypes and to 2 mm. among other individuals).

Pedipalps reaching beyond the middle of the patella of the anterior legs (or in some reaching only base of patella); principal claw about half as long as distal process of chelicera; on either side of principal claw is an accessory claw about two-thirds as long as principal claw, that on outer side farther from principal claw than that on inner side; setae of inner side of claw bearing segment simple, most of them arranged into two combs, each of which becomes somewhat irregular basally so that it is difficult to state the number of setae in the combs, in some paratypes combs are longer and more regular than in figure; combs close together so that under low power they may appear as one; distal setae of distal (lower) comb progressively shortened and thickened, the distal one about as long as accessory claw; finger more or less parallel sided, reaching apex of claw, its hairs and those of outer side of claw-bearing segment finely plumose. *Chelicerae* with distal process broad, sickle-shaped, acutely pointed, with fine teeth on concave margin. *Crista* rod-like, with an internal projection extending a short distance behind the pseudostigmatic area which is transverse, truncate behind; pseudostigmatic organs simple, arising from lateral angles of pseudostigmatic area. *Eyes* elevated, sessile, in the usual position above anterior coxae, the anterior ones considerably (or but slightly) larger than the posterior. *Body hairs* dense, of a single type, arising from small papillae which are broadest distally; hairs not thickened, main axis broadest at base, strongly plumose; hairs of posterior part of body not longer than those of shoulders. *Genitalia*: Apodemes of penal cone of male considerably longer than cone. *Legs* with many plumose hairs with shorter branches than the body hairs; first and fourth pairs longer than the body (except in individuals whose bodies are swollen, as gravid females), others scarcely shorter than body; forelegs with femora about equal in length to the last tarsal segment and only slightly longer than the intervening three subequal segments (in some all five segments subequal), last tarsal segment somewhat enlarged, two and one-half to nearly three times as long as broad, its claws about three-fourths as large as those of other segments; second and third pairs of legs with femora longer than patella, the following segments progressively longer than patella, the first tarsal segment about equal to femur; fourth legs with trochanters somewhat swollen, the following segments subequal except for the first tarsal segment which is longer than the others.

Holotype female, *allotype* male: Juna Mina, Canal Zone, Panama, March 15, 1945. One hundred and seventy-one *paratypes* from the same locality, March 7, 15, and June 10, July 2, August 8, 15, and 29, September 12, October 17, 1945. An additional specimen was collected in a roadside ditch near Juan Diaz, Panama Province, Panama (R. Melvin).

Growth during the adult stage apparently is unusual in this species, but a very few specimens which are apparently subadults have been collected. These differ from ordinary adults principally in their smaller size (length 0.7 to 0.9 mm.).

The apparently three-clawed apex of the pedipalp is somewhat similar to that of *Microtrombidium arborealis* Boshell and Kerr, a species which, however, has thickened and wholly different body hairs.

Egg: Smooth, red, spherical, about 0.15 mm. in diameter, laid in masses of 85 to 120 or more.

Deutovum: Dull red, more elongate than in other species studied, as shown in figure; two adjacent dorsal spines present, one on each side of midline of body; body surface minutely papillate.

Larva: Length about 0.24 mm. when unengorged. Color red. Larval characters are shown in the accompanying figure. Pedipalpal claw trifid as shown in *M. maculatum*, but often appearing bilobed because of the apical curvature of claw. Anterior dorsal plate defined only at its rear margin; branches of body hairs short, fine, and inconspicuous; inner hair of the anterior coxa commonly merely forked instead of three branched as shown.

Protonymph: Saclike, finely and sparsely tuberculate. Color red.

Nymph: Length 0.66 to 0.93 mm. Agreeing with the description and figures of the adult except as follows: setae of inner surface of tibia of pedipalp only about nine in number, four to six of them arranged to form a single comb of widely spaced coarse setae; finger not attaining apex of claw, finger provided with a few coarse simple setae at apex; genital area with but two pairs of suckers; body hairs sparser than in adult; anterior legs with last tarsal segment slightly longer than other segments.

Preadult: Differs from protonymph only in larger size.

Bionomics: This species occurs with *M. maculatum* on floating plants of *Pistia stratiotes*. It is about as abundant as that species or in some areas more so, although because of its smaller size and usually duller coloration it is less conspicuous. All the comments under *M. maculatum* concerning the behavior of nymphs and adults and the seasonal occurrence of the species apply also to *M. pistiae*.

Adults have been observed apparently feeding on dead bodies of chironomid midges floating on the water surface. Eggs almost completely fill the bodies of gravid females, which appear shriveled after egg laying.

In this species there are normally no molts after reaching the adult stage. This fact is indicated in Table IX in which it is shown that nymphs, in a single step, become adults of maximum size, and that even the smallest adult females are able to lay eggs. Out of approximately 190 specimens measured, however, there were three males which probably represent a subadult stage. Possibly under conditions of minimum food supply and slow growth such a stage occurs. There is no proof that such small adults (i. e., subadults) molt again in this species, but since adult molts are normal but variable in number in the related *M. maculatum*, it is possible that they occur rarely and under certain conditions in *M. pistiae*.

An examination of a series of specimens of this species always reveals some in which the body hairs are densely packed and others in which the hairs appear relatively widely separated. The former are freshly molted individuals. The latter are those which have grown, with resultant stretching of the body integument, after the molt. As this species attains full size with relatively few molts, this stretching is considerable and its effect on the density of the body hairs is noticeable.

Microtrombidiium fluminis n. sp.

Adult: A small bright red species with body hairs of a single type, thickened, blunt apically, with numerous fine branches. The finger of pedipalp is small, conical, and much exceeded by the claw.

Length 0.85 mm. (varying from 0.8 to 1.4 mm. among the paratypes).

Pedipalps reaching about middle of patella of first pair of legs; principal claw small, less than one-third as long as distal process of chelicera; inner side of tibia with accessory claw two-thirds to three-fourths as long as principal claw, arising close to the base of the latter, and with one comb of about four widely separated spines which are shorter and coarser than the scattered hairs of the segment, and

TABLE IX

Microtrombidium pistiae

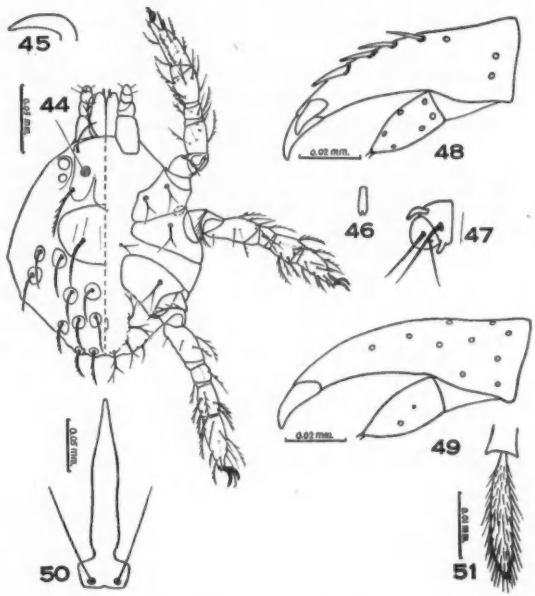
FREQUENCY DISTRIBUTION OF MEASUREMENTS (IN MILLIMETERS) OF LAST SEGMENT OF FORELEG

N = nymph, M = adult males, F = adult females. Figures under "eggs" show the number of individuals of each size class which laid or contained eggs. Lines under "growth of individuals" show the amount of growth at one molt of certain female mites.

	N	M	F	Eggs	Growth of Individuals
.13–.14	6				
.15–.16	8	3			
.17–.18		1			
.19–.20		14			
.21–.22		36	3	1	
.23–.24		23	10	1	
.25–.26		16	25	5	
.27–.28		1	24	4	
.29–.30		2	7	2	
.31–.32			1	1	

progressively coarser distally; outer side of tibia with scattered hairs only; finger small, tapering to a point, reaching to base of claw, its hairs conspicuously barbed. *Chelicerae* with distal process sickle-shaped, sharply pointed apically, the concave margin minutely dentate. *Crista* thick, tapering to a point anteriorly, slightly narrowed immediately anterior to abruptly expanded pseudostigmatic area which is wider than long and about twice as wide as crista at its widest point; pseudostigmatic organs rather short, simple. *Eyes* sessile, two on each side, anterior ones smaller than posterior; eyes not above anterior coxae but located antero-laterally from pseudostigmatic area, from which they are separated by only half width of this area. *Body hairs* of a single type, each arising from a large papilla which is broadest apically, hair arising from a cup-shaped apical concavity in papilla; hairs slender basally but otherwise much thickened, terminating bluntly, and provided with numerous fine setulae; axes of ventral hairs slightly more

slender than of dorsal ones. *Genitalia* with inner plates unusually broad, only about four times as long as broad (penal cone not clearly visible). *Legs* and pedipalps with hairs slender and for the most part plumose, not resembling the body hairs; first and fourth pairs of legs about as long as body, others shorter; forelegs with femur longer than patella, the latter equal to first tarsal segment but longer than tibia, second tarsal segment longer than femur, dilated, about two and one-half times as long as broad, claws about two-thirds as large as those of other legs; second and third pairs of legs each with femur slightly longer



Microtrombidium fluminis Michener. 44, larva; 45, apex of chelicera of larva; 46, pedipalpal claw of larva; 47, apex of pedipalp of larva; 48, inner view of tibiæ and tarsus of pedipalp of adult; 49, outer view of same; 50, crista of adult; 51, body hair of adult.

than the subequal patella and tibia, equal in length to first tarsal segment, but much shorter than second; fourth legs with trochanters dilated, femur slightly longer than the subequal patella and tibia, much shorter than either tarsal segment, first tarsal segment scarcely shorter than second.

Holotype (male?): Summit, Canal Zone, Panama, April 4, 1945. Three *paratypes* from the same locality. Thirteen additional *paratypes* from Tocumen, Panama Province, Panama, March 25 and April 1, 1945. Specimens were also taken at Camarón, Panama Province, Panama, March 19, 1945.

The small finger of the pedipalp of this species suggests ***M. pusillum*** (Hermann), ***columbianum*** Berlese, ***balzani*** Berlese, ***confusum*** Berlese, and ***soperi*** Boshell and Kerr. Of these species only ***confusum*** has body hairs similar to those of ***fluminis***, but that species apparently differs by the more numerous and closely spaced bristles of the pedipalpal comb.

Egg: Bright red, smooth, spherical, laid in masses of about twenty

Deutovum: Observed but unfortunately not preserved for study.

Larva: Length 0.17 mm. Color red. The characters are shown in the accompanying figure. The minute pedipalpal claws appear bilobed as shown, but may actually be trifid, as with certain other species whose claws appear bilobed in certain views. Noteworthy features are the trilobate anterior dorsal plate, the simple claws of the posterior legs, and the absence of median claws on the front and middle legs.

Protonymph: Unknown.

Nymph: Length 0.6 mm. Bristles of comb of pedipalpal tibia slender, three in number; crista almost or completely broken just in front of pseudostigmatic area; pubescence sparse, the body hairs much more slender than in adults but nevertheless distinctly thickened and ending bluntly.

Preadult: Sac-like, to judge by examination of a live specimen through nymphal integument.

Bionomics: Nymphs and adults of this species have been found running actively among moist dead and decaying leaves along the edges of pools and puddles in small drying stream beds at the end of the dry season. Some have also been taken running over damp rocks a few inches from the edges of similar pools.

The egg masses have been found in the field among the moist dead leaves where the adults occur. One was also laid in a rearing jar, among similar leaves. Larvae appeared on April 2 from a mass laid on March 26. Deutova were observed but unfortunately not preserved or described.

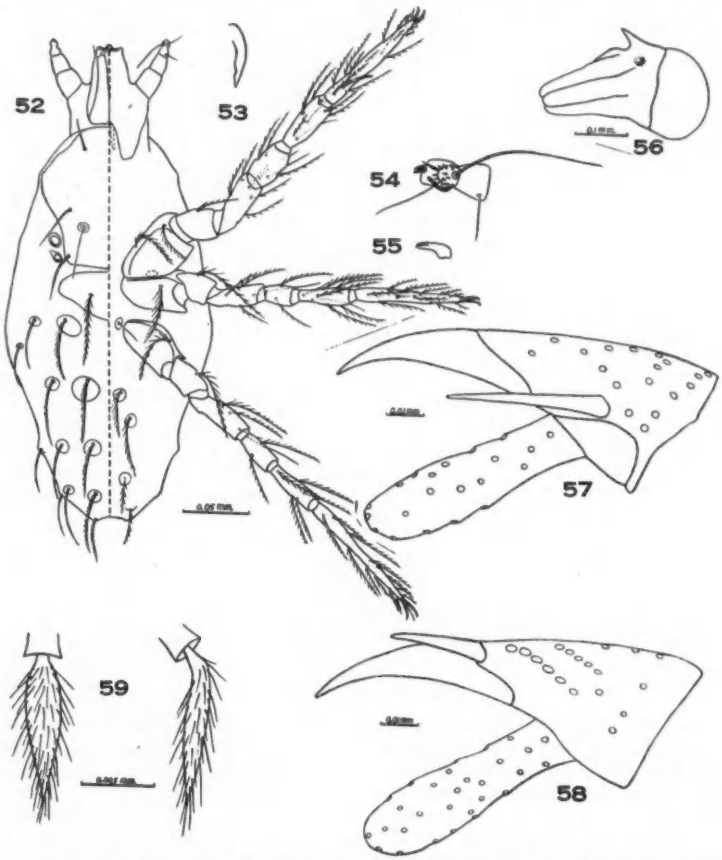
Apparently there are no adult molts in this species although evidence is meagre. All adults collected were more or less the same size. One individual was collected as a preadult. The outside integument was that of a nymph and the mite which emerged was an adult as large in measurements of the appendages as those which laid eggs.

Microtrombidium littorale n. sp.

Adult: This is a small, very bright red, rather elongate species. The hairs are of a single type in any one area of the body. They are thickened but pointed at the tips. The tibia of the pedipalp is provided with two oblique combs or bristles.

Length 1.02 mm. (varying from 0.83 to 1.10 mm. among paratypes). *Pedipalps* reaching middle or apex of patella of anterior leg; principal claw about as long as distal process of chelicera and approximately the length of pedipalpal tibia; inner surface of tibia with slender accessory claw about half length of principal claw and two oblique combs, each consisting of five or six coarse bristles; bristles of distal comb coarser

and with larger bases than those of basal comb (basad of combs are sometimes one to five simple setae); outer surface of tibia with large spine, nearly as long as claw, arising above base of finger; finger reaching to apex of claw, slightly more slender basally than apically, covered, like outer surface of tibia, with plumose setae. *Chelicerae* with distal process short, broad, acutely pointed, minutely dentate on concave margin. *Crista* slender, rod-like, with short internal projection, scarcely longer than broad, extending behind pseudostigmatic area; pseudostigmatic area roughly round, tapering anteriorly, with pseudostigmatic



Microtrombidium littorale Michener. 52, larva; 53, apex of chelicera of larva; 54, apex of pedipalp of larva; 55, pedipalpal claw of larva; 56, deutovum; 57, outer view of tibia and tarsus of pedipalp of adult; 58, inner view of same; 59, body hair in dorsal and lateral view.

organs arising posteriolaterally; pseudostigmatic organs simple, only about half as long as crista. *Eyes* sessile, in usual position above anterior coxae, the anterior ones slightly larger than posterior. ***Body hairs*** of a single type (except for certain areas), arising from large papillae which are broader distally than basally; hairs bent posteriorly near bases, somewhat flattened, narrow at bases, rather abruptly broadened near bases so that they are broadest subbasally or medially, tapering thence to pointed apices; hairs covered with numerous fine setulae; ventral hairs more slender than dorsal; areas laterad of eyes and connected by a narrow band behind pseudostigmatic area with even more slender and longer hairs, some of them scarcely thickened. *Legs* with hairs plumose, not thickened; legs rather slender, all shorter than body, anterior and posterior pairs much longer than others; fore legs with femur, tibia, and first tarsal segment subequal, patella somewhat shorter (or tibia and patella equal, both shorter than femur and first tarsal segment), second tarsal segment longer than other segments, much swollen, 2.2 (2.0 to 2.3) times as long as broad, its claws about two-thirds as large as those of other segments; second and third pairs of legs with segments following femur progressively longer, second tarsal segment much longer than any of the others, about as long as patella and tibia together; fourth pair of legs also with segments following femur progressively longer, but second tarsal segment but little (sometimes not at all) longer than first.

Holotype male, *allotype* female, and thirty-three *paratypes* from Old Panama, Panama, November 27, 1945 (C. D. and Mary H. Michener).

This species does not closely resemble any described American form. The shape of the papillae of the body hairs suggests ***Microtrombidium wilsoni*** Boshell and Kerr, among others, but the hairs themselves are scarcely thickened in that species. Evidently *M. littorale* is related to the European *M. stimulans* Berlese.

Egg: Bright red, smooth, spherical, 0.11 to 0.13 mm. in diameter, laid in masses of ten to thirty-five.

Deutovum: Legs elongate; dorsum with two large spines strongly diverging from one another.

Larva: Length about 0.29 mm. Color red. Characteristic features shown in fig. 52. Pedipalpal tibia with median constriction, the distal portion being flattened and projecting over the tarsus and bearing the small claw at its apex; median claws absent on first two pairs of legs; dorsal plates conspicuously longitudinally striate.

Protonymph: Unknown.

Nymph: Length 0.65 mm. Agreeing in general with description of adult; tibia of pedipalp with only one comb of three to five bristles, apparently corresponding to distal comb of adult; body hairs sparser than in adult but otherwise similar.

Preadult: Unknown.

Bionomics: This species was very abundant in an area near Old Panama. It has not been found outside of the intertidal zone, and barnacles and marine snails are found as much as four and one-half feet above the level where the mites occur. Nymphs and adults are exceedingly active and run rapidly over the surface of mud, even in bright sunlight, in a mangrove swamp as well as where mud formed a

thin covering over rocks some distance from the mangroves. The surface of the mud where these mites were collected was partly covered by an inconspicuous filamentous green alga. The broad bare mud flats evidently are not a suitable habitat for this species. When disturbed by attempts to catch them, and doubtless also by the rising tide, they go into small holes in the mud, of which there are many, mostly made by small polychaete worms.

The egg masses are laid in holes in the mud. In the laboratory it has been found necessary to remove the eggs from rearing jars as soon as possible after laying, as otherwise they are eaten by the mites. Frequent submersion in sea water does not seem to be necessary for life in this species, as the mites live well in rearing jars containing some mud kept moist by keeping the jar sealed. In such jars adults lived for over a month.

The duration of the egg stage in this species is about ten days, of the deutoval stage ten to twelve days.

There is no great variation in the size of adults in this species, and it is reasonably certain that adult molts do not occur.

Microtrombidium arborealis Boshell and Kerr

Microtrombidium arborealis Boshell and Kerr, 1942, Rev. Acad. Colombiana Cien. Exact., Físic. Nat., vol. 5, p. 123.

Specimens of this species were collected beneath a log at Santa Rosa, Colon Province, Panama, August 29, 1945. Another was found at Juan Mina, Canal Zone, Panama.

It is worth pointing out that this curious species is related to *M. distinctum* (Canestrini) from the Old World tropics.

Several other species of trombids were collected in small numbers during the author's stay in Panama. These included two species related to *Microtrombidium duartei* Boshell and Kerr, one additional species of *Manriquia*, etc.

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PROTALLAGMA RUNTUNI KENNEDY, 1939, A SYNONYM OF OXYALLAGMA DISSIDENS (SELYS), 1876: NOTES ON OXYAGRION AND RELATED GENERA

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In 1939 the writer described *Protallagma runtuni*, a Coenagriid dragonfly from the high Parana of Ecuador at elevations of 4,550 to 6,250 ft. Because of similar high elevation, similar stature, hairiness, color pattern, penis and male abdominal appendages, with only slight differences in venation it was associated with *Protallagma titicacae* (Calvert), 1909, from the similar high plains about Lake Titicacae, Peru. A thorough enough check in the scattered literature of Andean forms was not made. In a recent review of several species of Oxyagrion in the writer's collection in an attempt to identify described forms it was discovered that *Protallagma runtuni* Kennedy was described by de Selys, 1876, as *Oxyagrion dissidens* from Quito. De Selys placed this aberrant species by itself in "Group 1" of his genus Oxyagrion. The writer himself (1920) had erected the genus Oxyallagma for *dissidens* as based on material in the Williamson collection which had been sent by Campos of Guayaquil, Ecuador, with the exact locality not indicated. The description of Oxyallagma gen. nov. (1920) reads, "Characters as in Enallagma, except red a dominant color, no postocular spots, and penis without lateral lobes." *Runtuni* is thus a synonym of *Oxyallagma dissidens* (Selys).

We offer no apologies. Only one who has worked with de Sely's descriptions in Oxyagrion, and Acanthagrion will appreciate the resulting confusion and the possibility of one's forgetfulness of his own genus.

De Selys established Oxyagrion for the red species and Acanthagrion for the blue species. Curiously enough a partial check of elevations suggests that the red species (Oxyagrion) are usually found at lower elevations while the blue species (Acanthagrion), much more numerous, occur at low and medium elevations. We may be dealing with one large genus which can throw red forms from blue forms or *vice versa*. M. J. Leonard of Ann Arbor, University of Michigan, has an unpublished manuscript on the Acanthagrions of the Williamson and Kennedy collections. One of his sets of figures of penis and appendages of an unnamed species of Acanthagrion appear to be identical structurally with a red Oxyagrion from Brazil in the writer's collection. Actual specimens of the two (?) species have not been studied side by side. The writer hopes to compare them.

De Selys' descriptions of South American Odonata will in many cases remain enigmas until some generous and skilled European odonatist will publish careful drawings of penes, appendages, and color patterns of the de Selys type material. Good drawings are a must on

South American species. Calvert started the work and was followed later by E. B. Williamson and Ris. They have figured described species as well as their own new species.

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CATALOGO DE LOS DIPTEROS DE CHILE, by CARLOS STUARDO. 250 pages, 1946. Published by the Ministerio de Agricultura, Direccion General de Agricultura, Santiago de Chile.

A prologue by Charles P. Alexander testifies to the richness of the dipterous fauna of Chile. He states that this is true "particularly of the so-called Santiagan and Valdivian faunal districts that extend from the general vicinity of Coquimbo at near latitude 30°, southward to just beyond the 45th parallel, or to the general region of the Rio Aysen. In this approximately 1000-mile area there is to be found a concentration of generalized types of Diptera that is approximated elsewhere only in Australia and, to a lesser degree, in New Zealand." With this opinion of a leading authority on the order one must conclude that a comprehensive catalog of the flies of the region is an important contribution, as one must also agree with Dr. Alexander that a catalog is a tool of the greatest importance to the taxonomist.

Professor Stuardo lists the amazing total of 2,143 species. His introduction shows how thoroughly he has laid the foundations for the catalog, both on the basis of the literature and through the collaboration of specialists in the order. The result is an enviable example of taxonomic cataloging.

Following the introduction the titles of periodicals cited in the text are listed with the abbreviations used. The body of the work is in a very clear form. Genera and major categories are set in bold-faced type as center heads, without bibliographic entries. Under each genus specific names are also in bold-faced type and the condensed bibliographic material is indented, leaving the name of the species doubly easy to locate. Synonyms are in italics, separately paragraphed under the major bibliography of the species. Where necessary a list of "Species incertae sedis" is placed at the end of each family. The description of a new genus, *Pritchardia*, type *Hypenetes hirtipes* Macquart, on page 80, may be of interest beyond the limits of the order.

Descriptions of two new species of *Ocnea* by Dr. Curtis W. Sabrosky follow the body of the catalog.

Nineteen pages of bibliography and an index to scientific names complete the catalog.

The quality of the paper is inferior to the typography but it appears to be durable stock, capable of withstanding the abundant thumbing to which a catalog is subjected. The cover is heavy paper.

Professor Stuardo is to be congratulated on a monumental contribution to the taxonomy of South American insects.—A. W. L.

HYBRIDIZATION AND FEMALE ALBINISM IN COLIAS PHILODICE AND C. EURYTHEME. A NEW HAMPSHIRE SURVEY IN 1943 WITH SUBSEQUENT DATA

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The gradually advancing incursion of the orange-colored alfalfa butterfly (*Colias eurytheme*) into the north-eastern States, still abundantly populated by its near relative, the sulphur-yellow clover butterfly (*C. philodice*), is attended with measurable natural hybridization. This is more conveniently studied in a region such as this where *eurytheme*, formerly absent, is still relatively uncommon. In other eastern localities where *eurytheme* may exceed *philodice* in abundance, detection of hybrids, owing to the extreme variability of *eurytheme*, is more difficult.

In a study of evolutionary dynamics involving "speciation," it is essential to define "species." As here used, it is a group in large degree physiologically isolated from its nearest relatives by partial or complete lack of fertility. This, my experience shows (Gerould, '43), is true of the orange *eurytheme* and that complex of yellow sub-species, *eriphyle-philodice*, in many localities associated with it and probably derived from it. *Eurytheme* and the races of *eriphyle* (western) are in certain regions "sympatric," in the sense that they occur there together more or less simultaneously, though their food requirements so far as investigated, are somewhat different. Both lay their eggs on various members of the pea family and can be raised readily on white clover (*Trifolium repens*), though *eurytheme* thrives best on the alfalfas; *eriphyle* oviposits chiefly on white clover in mountain pastures. Hovanitz ('43) had difficulty in raising *eriphyle* of eastern California on alfalfa.

For many years *philodice* in the eastern States was geographically isolated from *eurytheme*. In the Mississippi Valley, into which *eurytheme* had already penetrated from the far west and the Rockies, it was sympatric with *philodice*, and hybridization between them occasionally but very rarely occurred. In recent years, apparently due largely to the gradual introduction of alfalfa, its preferred food plant, *eurytheme* has spread eastward in considerable abundance even to the Atlantic coast, and hybrids, once a great rarity, have recently been found in larger numbers. What influence hybridization may have upon the population, as the vigorous, brilliant-orange *eurytheme* moves eastward, is the problem which confronts us in the studies now being initiated.

In our 1940 survey at Hanover, N. H. (Gerould, 1943), *eurytheme* was still exceedingly rare. In the sample of 658 individuals collected and preserved, 648 were *philodice*, 5 *eurytheme* and 5 were hybrids. This might lead to the incorrect prediction that hybrids would later

be as common as ordinary, relatively homozygous, ***eurytheme***. The fact, however, that only a single ***eurytheme*** female was then taken suggests that the few invading ***eurytheme*** males, meeting almost no females of their own kind, found mates, if at all, among the abundant ***philodice*** females.[1] Two of these five hybrids were clearly F_1; three were paler and evidently of a backcross of ***philodice***. All were males. Their size, evenly distributed intermediate-orange coloration, and seasonal association with brilliant orange males exclude the possibility that they were "***ariadne***," the dimunitive, pale and orange-spotted, late-fall-and-spring form of ***eurytheme***.

SUMMARY OF SURVEY IN 1940

(September–October)

philodice			*eurytheme*			hybrids	
	yellow	white		orange	white		
♂	♀	♀	♂	♀	♀	♂	♀
404	202	42	4	1	0	5	0 = 658
Total n = 648				5			5
% = 98.48 ± .48				0.76 ± .34			0.76 ± .34 = 100

Three years later (Sept.-Oct., 1943) the foreign population (***eurytheme***+hybrid) had become fairly common 9.2±.7%, n=1852). The proportion of hybrids to pure ***eurytheme*** was then no longer apparently equal, as in 1940, but had decreased to 7.0±2.0%, n=171.

Making up the whole 9.0% of foreigners were 159 ***eurytheme*** and 12 hybrids, 10 of which (8 ♂♂ + 2 ♀♀) were easily recognized as F_1 by their intermediate-orange ground color; 2 (1♂ + 1 ♀) were paler, of a backcross to ***philodice***.

The 1852 specimens collected in 1943 were preserved for re-examination and further study. Each day's catch was filed away separately. Publication of these daily records is here omitted, but, in testing the randomness of the whole sample, we may compare the 1090 collected by school children and teachers with those (762) by me personally. The percent of ***eurytheme***+hybrids in these two main lots differs. We find 7.4% in that of the school, 11.8% in my own. This difference may be due to my particular interest in the immigrants, occasionally inducing me to capture one of them rather than the nearest available ***philodice***, though a constant effort was made toward random sampling. The school percent is only 1.8% below that of the whole (viz., 9.2), whereas my own is 2.6 above it, indicating that 9.0% would be a better combined average of all ***eurytheme***+hybrids than 9.2.

Comparing the sex ratios in the two lots with that of all combined, we find altogether 60% ♂♂ + 40% ♀♀; in the school collection 60.8% are ♂♂; in mine 59.7, both practically the same.

The total population sample in 1943 stood at 90.77% ***philodice***,

[1]In experiments of 1913–'14, Gerould, '43, ***eurytheme*** males of Arizona stock showed less inclination in cages to cross with ***philodice*** females than ***philodice*** males with ***eurytheme*** females.

8.58% ***eurytheme*** and 0.65% hybrid. The presence of 42 ***eurytheme*** females showed that the 117 males of this later date had ample opportunity to mate within their own species; one such couple was captured. That they were generally doing so is indicated by the fact that the ***eurytheme*** caught outnumbered the hybrids 13 to 1. The total sample included 1681 ***philodice***, 159 ***eurytheme*** and the 12 hybrids.

SUMMARY OF SURVEY OF 1943

(September–October)

	philodice			*eurytheme*			hybrids		
		yellow	white		orange	white		orange	white
	♂	♀	♀	♂	♀	♀	♂	♀	♀ = 1852
	992	528	161	117	35	7	9	3	0
Total n = 1681				159			12		
% = 90.77 ± .68				8.58 ± .66			0.65 ± .18 = 100		

Data of 1945: Two years later (September 6–October 22), although weather conditions were generally unfavorable, on eleven sunny afternoons I collected 301 specimens, of which 24 (8. %) were ***eurytheme***+ hybrids, a slight decrease from the 9. % obtained in 1943, though much larger than the 1.5% found in 1940. The percent of hybrids among them in 1945, however, was larger than in 1943 when, among 164 orange males and females, 12, or 7.3%, were hybrids. In 1945, 20.8% of the 24 orange individuals, viz., 5 (4 ♂♂ + 1 ♀) were hybrid. Included with them, however, is one male which, verging toward pure ***eurytheme***, was listed as a backcross. Excluding this doubtful male, we would have 4 hybrids among the 24 orange "foreigners," or 16.6%, and 1.33% not 1.66% in this relatively small colias population sample as a whole.

SUMMARY IN 1945

	philodice			*eurytheme*			hybrids		
			white			white			hybrid
	♂	♀	♀	♂	♀	♀	♂	♀	♀ = 301
	153	98	26	15	4	0	4	1	0
Total n = 277				19			5		
% = 92.0 ± 1.7				6.3 ± 1.4			1.66 ± .73 = 100		

It will be noted that the percent of hybrids in these *Colias* population samples as a whole in 1940 and again in 1943 was less than 1. %; in 1945 it was approximately 1.5%.

FEMALE "ALBINISM" IN RECENT NEW HAMPSHIRE SURVEYS

As is well-known, a measurable proportion of the females in any population of *Colias* ***eurytheme*** and of *C.* ***philodice*** is white. These are not genuine albinos as defined in Vertebrates, for the black borders and the orange-yellow central spots of the hind wings are like those of

their respective "colored" sisters, but the ground-color pigment (orange or yellow) has been replaced by white.

This genetically dominant white female color in northern *Colias* populations occurs in higher proportions than in southern (Hovanitz, 1944c). The percentage of white females in *Colias eurytheme* in western California was found by him to vary from 13% in extreme southern localities to 69% in North San Joaquin Valley (latitude of San Francisco).

In our earlier, or 1940, survey at Hanover, N. H. (Sept. 11–Oct. 16) the total of 244 *philodice* females caught and studied included 42 white, 202 yellow, i.e., $17.2 \pm 2.4\%$, white. No white female *eurytheme* was taken, and in fact only one orange female. In my note in GENETICS (Gerould, 1941), the smaller number caught by me personally was reported, agreeing with a study made in the spring of 1911 (Gerould, 1923) which also gave 16 percent white.

Three more recent surveys, two in the autumn of 1943, including that at Hanover already partially described and another at Acworth, N. H., gave further data on white female populations. In those of 1943 the help of school-children was enlisted. They were instructed to capture all the white butterflies they saw (including the "cabbage" white, *Pieris rapae*) so that we should miss no white females of *Colias*.

Acworth, N. H., is about 35 miles south of Hanover on hills 8 or 10 miles east of the Connecticut River (altitude about 1500 ft., cf. 500 at Hanover). This collection ($n = 144$) was made under the direction of Mr. James E. Peabody and a school teacher, Mrs. Murdough, Sept. 10–23, 1943.

It contained a slightly larger proportion of *philodice*, 91.6 ± 2.3 per cent, $n = 144$, than that at Hanover ($90.8 \pm 0.7\%$, $n = 1942$). The remaining 8.4% consisted of 8 ♂♂ and 3 orange ♀♀ of *eurytheme* too badly damaged for identification of hybrids, if any. No white *eurytheme* ♀ was caught, but 6 of the 29 *philodice* ♀♀ were white, i.e., $20.7 \pm 7.5\%$, a proportion very slightly smaller than that taken simultaneously at Hanover. In 1945 at Hanover, 26 of the 124 *philodice* ♀♀ ($21.0 \pm 3.7\%$) were white.

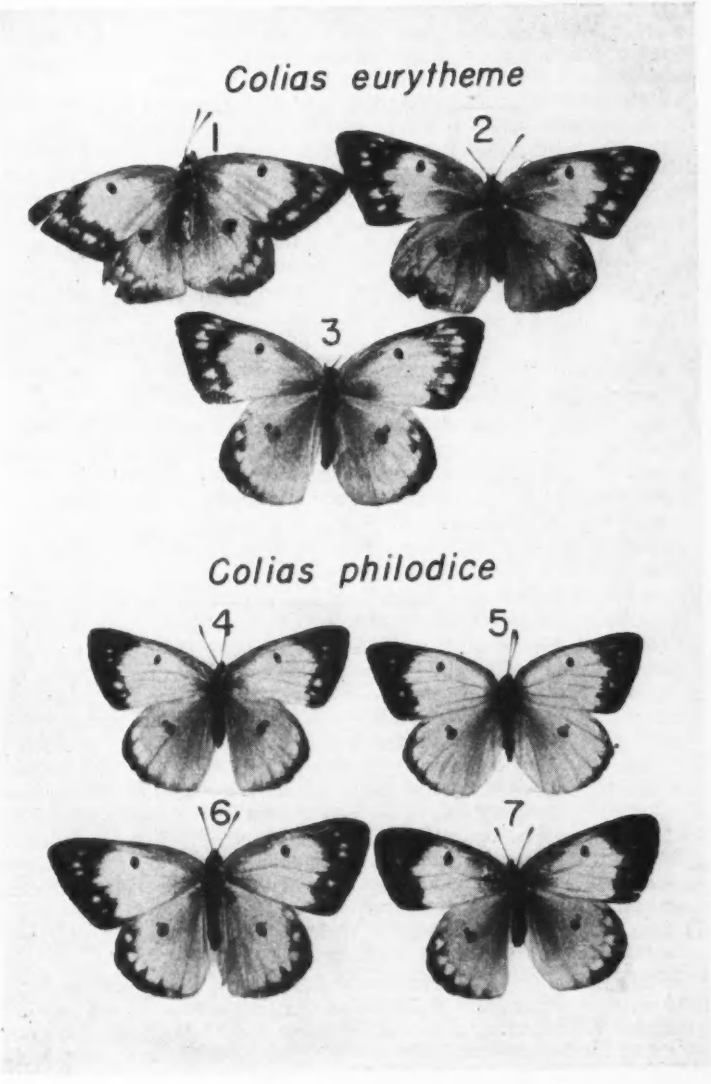
Hanover, N. H.: As already stated, the earlier, or 1940, survey gave $17.2 \pm 2.4\%$ ($n = 244$) white *philodice* ♀♀. In 1943, it was $23.4 \pm 1.6\%$ ($n = 689$) in *philodice*. Of *eurytheme* in 1943, 42 ♀♀ were taken, exclusive of 3 hybrids, with 117 ♂♂; 33 of these ♀♀ were orange, 7, or $16.7 \pm 5.7\%$, were white. Combining white ♀♀ of both *eurytheme* and *philodice* taken at Hanover in 1943, $22.9 \pm 1.5\%$ ($n = 734$) were white.

Female hybrids, exclusive of whites, were 3 (0.53% of all orange ♀♀). This ratio when applied to all the whites (168) would amount to 0.89, or slightly less than one individual. None was positively identified as such.

EXPLANATION OF PLATE I

White females, natural size, from the 1943 survey.

Figs. 1–3 are *Colias eurytheme;* 4–5, typical *C. philodice;* 6–7, *C. philodice* with intermediate color pattern. 6 may be an F_1 or other hybrid, but has been listed as *philodice*. (See the text, p. 384). Fig. 1, Sept. 27 (J. H. G.); 2, Sept. 19 (Berry and Blossom); 3, Sept. 19–20 (Jr. Nat. Hist. Club); 4, Sept. 12 (J. H. G.); 5, Sept. 13 (J. H. G.); 6, Sept. 12 (J. H. G.); 7, Sept. 13 (J. H. G.).


Colias eurytheme
1
2
3
Colias philodice
4
5
6
7

Absence of ground-color contrasts in white ♀ ♀ forces one, in the study of captured specimens, to depend upon color-pattern differences in judging whether they belong to ***eurytheme***, ***philodice*** or are possibly hybrid. Any white hybrid would be looked for among the few whites of intermediate color-pattern included in our list of 161 white ♀ ***philodice***.

Before critically examining these intermediates, let us first inquire into the traits of the 7 whites regarded as unmistakably ***eurytheme***. They agree in having: fore-wing black border wide, marked with an almost continuous curved row of large spots of white ground-color. Black discal spots large. Posterior (inner) half of the fore wings touched with faint orange in the 4 freshest specimens.

Hind-wing border broad, extending inward half-way to the central spot and enclosing large spots in the more extreme cases.

Central orange spot brighter (redder) than in ***philodice***.

DISTINCTIVE TRAITS OF THE SEVEN WHITE EURYTHEME FEMALES OF 1943. (UPPER SURFACE ONLY)

All agree in having ***large*** black discal spots.

(1) Sept. 27 (J. H. G.), Pl. I, fig. 1. Fore-wing border has a complete row of fairly large spots; faintest possible orange flush on inner half of fore and hind wings. Hind-wing border extremely wide, enclosing 4 distinct spots; intensely bright-orange central spots.

(2) Sept. 14 (E. Horton). Fore-wing border wide with large spots. Hind-wing border of intermediate width and only a trace of attendant spotting. Central spots ***bright*** brick red.

(3) Sept. 18 (E. Horton). Both fore- and hind-wings with wide border marked with large spots. Central spots small, but bright orange.

(4) Sept. 19 (Berry and Blossom), Pl. I, fig. 2. Extremely wide borders of both fore and hind wings; spots of fore-wing border large; central spots bright orange. Faint orange suffusion near inner (posterior) edge of fore-wings. Melanic inner half of fore-wings and whole upper hind-wing surface.

(5) Sept. 19 (L. Chan). Like fig. 3 in width and spots of fore wing borders. Hind wings like fig. 2 but not so melanic. Inner two-thirds of fore-wings have a decided orange flush over the white.

(6) Sept. 19–20 (Jr. Nat. Hist. Club), Pl. I, fig. 3. Fore-wing border wide, with large spots. Indistinct orange flush over fore wings. Hind-wing border moderately wide with two spots near anterior edge. Central spots bright orange.

(7) Sept. 21 (W. Schaldach). Wide, spotted, borders. Melanic. Central spots moderately bright orange.

In my opinion, most observers familiar with *Colias* would probably agree in separating from ***philodice*** on the basis of color pattern this group of 7 white females. Unfortunately for diagnosis, however, fore- and hind-wing characters do not always coincide. Thus in (2) and in (6, Pl. I, fig. 3) the hind-wing borders are only moderately wide, with a minimum of adjacent spotting. The same is true of some of the white ***philodice*** pattern-intermediates which follow.

WHITE COLOR-PATTERN INTERMEDIATES CLASSED AS PHILODICE

Six of the 161 white females classed as ***philodice*** have some but not all of the distinctive color-pattern traits of ***eurytheme*** mentioned; they appear to me to be ***philodice***-like within the limits of its variation in this region. The first one to be described, however, may be an F_1 ***eurytheme*** × ***philodice***. It closely resembles, for example, some of a highly variable 1913 F_1 hybrid brood, and was caught on the same day as a definitely F_1 ♂.

(1) Sept. 12 (J. H. G.), Pl. I, fig. 6. Varies from average ***philodice*** in size and in respect to the hind-wing border, which is slightly wider than usual, with incipient spotting. Its fore-wing borders are of medium width with small spots; large discal spots. Central spots intermediate orange. Faint greenish suffusion above, over inner half of hind wings, not uncommon in ***philodice***.

(2; and 3, Pl. I, fig. 7), Sept. 13 (J. H. G.). Slightly melanic. Fore-wing borders have small, faint spots. Large discal spots. Hind-wing border intermediate, but with adjacent spots on the faintly melanic ground color. Central spots pale, or intermediate, orange.

(4) Sept. 19 (E. Horton). Below normal in size. Rounded fore-wings; large discal spots. Fore-wing border moderately wide with spots of intermediate size. Hind-wing border of intermediate width, with small adjacent spots on melanic background. Large central spots of intermediate orange. Ground color not of the usual dead white but faintly greenish yellow of an unusual tint.

(5) Sept. 18 (Jr. Nat. Hist. Club). Fore-wing border with extremely small spots. Hind-wing border slightly wider than in most ***philodice***, with two incipient spots. Central spots pale orange.

(6) Sept. 18. Fore-wing border with small spots. Hind wings slightly melanic, with row of clear spots adjacent to border of intermediate width. (5 and 6 are like Pl. I, figs. 6 and 7, in pattern.) Large, double, fairly bright-orange central spots.

Conclusion as to the six pattern-intermediates: It is evident that the color-pattern of none of them agrees in all respects with ***eurytheme's*** as I have defined it, but probably lies in each well within the limits of variation in ***philodice***, with which they have been listed. Only one of them, (1) Pl. I, fig. 6, shows evidence of possibly being a ***philodice*** × ***eurytheme*** hybrid. The small number (3) of pale-orange ♀ hybrids and absence of direct evidence are reasons against counting it as a hybrid. Though most white females can be readily distinguished as ***eurytheme*** or as ***philodice***, others, of intermediate color-pattern, are thus at present difficult to classify with such accuracy as is possible in distinguishing and classifying males and "colored" females as ***eurytheme***, ***philodice*** or hybrid.

WHITE FEMALE PERCENTAGE IN EURYTHEME

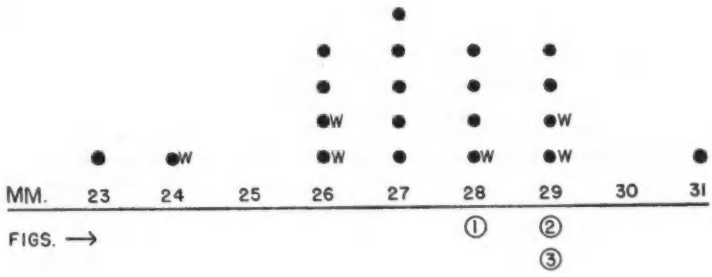
The number of white ***eurytheme*** females caught in 1943 is so small (7 in 42) that its slightly lower percent (16.7 ± 5.7) than that of ***philodice*** is probably not significant. If three ***philodice*** white females of "inter-

FORE-WING LENGTHS IN MM. OF 20 *C. EURYTHEME*
AND OF 20 *C. PHILODICE* FEMALES
(Sept. 13 – Oct. 19, 1943)

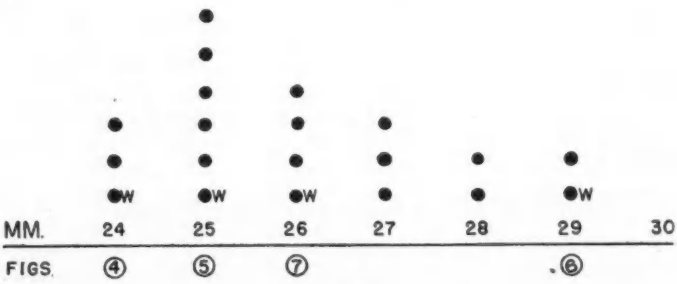
FOR SIZE OF SPECIMENS IN PL. I, FIGS. 1-7,
NOTE THEIR POSITIONS BENEATH BASE-LINE.

"W" AT RIGHT OF A MEASUREMENT MEANS WHITE ♀

C. EURYTHEME



C. PHILODICE



mediate" pattern were to be selected and transferred to ***eurytheme***, ***philodice's*** white ♀ percentage would be reduced only to 23.0, while ***eurytheme's*** would be raised to 22.2 (with large probable error) which is virtually the same as that for all whites combined, viz., 22.9. I am unable to select from among the six white "intermediates" here briefly described any three deserving priority for such a hypothetical transfer to ***eurytheme***.

FEMALE SIZE-DIFFERENCES, EURYTHEME AND PHILODICE

The obviously larger size of the white female of intermediate color-pattern of questionable standing (Pl. I, fig. 6) than the other white ♀ ♀ of ***philodice*** shown (Pl. I, figs. 4, 5, 7) suggested measuring the fore-wing length of 20 representative specimens of each species. They were random individuals of this survey suitable for accurate measurements. The graphs shown in Plate II indicate (1) that ♀ ♀ of ***eurytheme*** average larger in fore-wing length than ***philodice***, (2) that those in the natural-size photographs of Plate I (figs. 1–3) are slightly above the average for ***eurytheme***, while those of ***philodice*** shown in Plate I, figs. 4, 5, 7 are slightly below ***philodice's***. The ***philodice*** of intermediate pattern (fig. 6) is seen to be not beyond the range for that species though above its average. It will be noted that if this individual were to be counted as a hybrid (13th) rather than as ***philodice***, the percent of hybrids would become 0.7, rather than 0.65, that of ***philodice*** remaining at 90.7.

SUMMARY OF THE 1943 SURVEY AT HANOVER, WITH DATA ON WHITE FEMALES

philodice			*eurytheme*			hybrids		
	yellow	white		orange	white		pale-orange	white
♂	♀	♀	♂	♀	♀	♂	♀	♀
992	528	161	117	35	7	9	3	0=1852
Total	1681			159			12	=1852
Percent	90.77 ± .68			8.58 ± .66			0.65 ± .18	
Total n	689			42			3	= 734
White ♀ %	23.4 ± 1.6			16.7 ± 5.7				

Percent of all white ♀ ♀ combined = 22.9 ± 1.5 (n = 734).

For the 1943 collection of specimens at Hanover, I am greatly indebted to Mr. Douglas E. Wade, College Naturalist, to Misses Anna Blossom and Ruth Berry, William Schaldach and a number of younger collaborators.

My Dartmouth colleague, Dr. James Franklin Crow, especially deserves thanks for his friendly advice and assistance in presenting the statistical data.

HYBRIDIZATION NEAR WASHINGTON, D. C., AND IN EASTERN CALIFORNIA. A REVIEW

In Clark's (1932) classic work on the Butterflies of the District of Columbia, he describes in considerable detail the advent of ***Colias eurytheme*** into that region, with notes on its relative abundance as

compared with *C. philodice*. "In 1927 it was exceedingly abundant. In the higher and more exposed areas . . . its numbers were equal to more than half the numbers of the yellow clover (*Colias philodice*) when the latter was at its maximum. Indeed, on some days there seemed to be no difference in the frequency of the two species." In 1928: "On October 6 and 7 a careful count was made at Cabin John, and it was found to be just one-fifth as numerous as *C. philodice*." In 1930: "At the end of the summer it far outnumbered *C. philodice*." In 1932, again regarding *C. eurytheme*: "Whether it will continue as a permanent resident, or will decrease to its former status as a rather scarce late summer intruder, or will eventually entirely disappear, remains to be seen."

In this memoir (Clark, 1932), differences in color pattern and size between *C. eurytheme* and *C. philodice* are strikingly shown in his excellent plates No. 26 and No. 27. Typical large *eurytheme* females, with very wide black borders enclosing spots of ground color, are seen in Pl. 26, figs. 5, 6, 8. Fig. 3 is a "yellow female with a barely perceptible orange flush," probably a hybrid. Fig. 4 is a typical white *eurytheme* ♀ with large spots in the border; Fig. 8, another white ♀ "flushed with pink on the discal portion of the fore wings and with yellow on the hind wings." These *eurytheme* ♀ ♀ of Pl. 26 are markedly different in color pattern from those of *philodice* shown in Pl. 27, viz., Figs. 5, 6, 7. Fig. 5 has only vestiges of spots on the fore wing border; 6 and 7 are spring forms in which the hind wing border is extremely narrow; 8 is white, lacking spots altogether on the fore-wing border but having a slightly wider hind-wing border than is usual in *philodice*.

No further notes on *Colias* near Washington D. C., published between 1932 and 1941 have come to my attention. During those nine years, however, *eurytheme* appears to have increased in numbers, along with its hybrids, so that, on the basis of "a very large number of specimens" collected by Mr. W. H. Wagner, Jr., Clark (1941) solved his difficulty in distinguishing *eurytheme* and hybrids from *philodice* by writing a "composite description" which "covers all forms between the most extreme *eurytheme* (form *amphidusa*) and the most extreme *philodice*, including the yellow phase or variety of *eurytheme* and *eriphyle*."

This combination Clark called *C. chrysotheme* Esper after the small Austro-Hungarian orange butterfly which resembles the color phase of *eurytheme* formerly known as "*keewaydin*, W. H. Edw."

This superficial similarity led Hagen (1883) to identify *chrysotheme* with "keewaydin" (i.e., *eurytheme*) though not with *philodice;* and Elwes (1884) in an excellent article on this genus did exactly the same.

It seems to me unfortunate to lump the orange and the yellow "species" of this group, with their local hereditary diversities in morphology and physiology, under the name of a foreign species ranging from Vienna eastward into Siberia, about which, in ignorance of Russian entomological literature, I have been able to get very little information. Certainly no one can tell us whether *chrysotheme* Esper would mate with *eurytheme*, either with or without fertility. Moreover, we are still ignorant of the exact relation of *eurytheme* and *eriphyle* to other western American "species," such as the yellow *chrysomelas* of northern,

barbara of southern, California, and to the legume-feeding "*christina-emilia-alexandra* complex," an apparently hybrid combination exhibiting orange, yellow, and white-female colors.

Another objection to importing the name *chrysotheme* into America and applying it to *philodice* is that its use as a blanket term may tend to conceal facts about hybridization. Hybrids in a museum, when not recognized as such, become absorbed into a meaningless welter of "forms," and thus hybridization fails to be recognized as of importance in evolution.

Owing to war conditions and absence of collectors, it was not feasible in 1943 to make any quantitative survey of *Colias* near Washington, D. C. On August 31 of that year, Clark wrote me that: "Our *Colias* in this region seem now to have settled down into a stabilized hybrid form with, so far as can be seen superficially, relatively little variation." On September 20, '43, he wrote regarding Mt. Solon in western Virginia: "Here *philodice* is still common—about one-third of the total. All the individuals seen appeared to be pretty uniform, either yellow or orange—or white." Of these he sent me ten specimens to examine, 2 of which were *philodice* ♂♂ and 8 *eurytheme:* 3 ♂♂ + 4 ♂♂ + 1 very large white ♀,—a sample in line with his population estimate for that locality. There was no hybrid intermediate among them. All this refers to the lower mountain levels, whereas "practically the whole population in the higher mountain pastures" was *philodice.* "In the lowlands, conditions are quite different" (letter of September 27, '43). A series of intermediate forms were collected by him in southwestern Virginia, near Covington, similar to that made near Washington by W. Herbert Wagner, both lots of which were distributed through the collection and difficult to segregate. Consequently we must still wait until another favorable season arrives for definite quantitative data on the lowland population near Washington.

However, in the spring of 1945 two small collections were made for me at Charlottesville, Va., by Dr. Carl W. Gottschalk and Miss Sarah E. Roberts, which indicate that typical *eurytheme* (spring form) may have been four times as abundant as *philodice.* No hybrids were taken. There were altogether 25 *eurytheme* and 6 *philodice.* Of *eurytheme,* there were 14 ♂♂ and 12 ♀♀; 2 of these ♀♀ were white. The *philodice* were 3 ♂♂, 1 yellow ♀ and 2 white ♀♀.

Eight others (6 *philodice* and 2 *eurytheme*) from Charlottesville caught in the spring of 1941 included: 4 ♂♂ *philodice,* 1 yellow and 1 white *philodice* ♀, and 2 *eurytheme* ♂♂, but no hybrid.

Another collection of 29 made at Farmville, central Virginia, during the season of 1940 by Mr. Frank Trainer and Dr. Gottschalk, and sent to me by the latter, included the following:

3 *philodice:* 1 ♂, April 27; 1 white ♀, May 9; 1 yellow ♀, Sept. 8.

23 *eurytheme:* 16 ♂♂ (April 6–July 28); 6 orange ♀♀ (May 5–Aug. 18), 1 white ♀, April 29.

3 hybrids: 1 ♀ (pale orange), July 7; 1 ♂, Sept. 7; and 1 ♂, April 6.

The probable hybrid ♂ of April 6 was caught on the same day with seven small, ariadne-like ♂♂ of *eurytheme.* Compared with them, it is of average size. The reduced orange, along the inner

(posterior) edge of the primaries, and correspondingly less brilliant central orange spots are associated with a slightly wider black forewing border. On the strength of these slight differences, I regard it as almost certainly a hybrid. Summer hybrids, on the other hand, are very easily detected. The Sept. 7 ♂ is a perfect example of an F_1 hybrid.

Dr. Gottschalk wrote me (March 19, 1946) that the collections were made without "particular reference to species. *Eurytheme* is much more common."

The striking fact, perhaps, is not the increasing abundance of *eurytheme*, but rather the relative rareness of *philodice* in this region where it formerly was found exclusively. The explanation may be that *philodice* continues to use white clover almost exclusively (as first suggested by Hovanitz), while alfalfa is, at least, the preferred food plant of *eurytheme*, though, as I have shown, it lays and grows readily on white clover. That the huge size and intense orange color of "amphidusa" (a summer form of *eurytheme*) can be attained only by growth on alfalfa (and not on white clover) is probable, though not yet proved experimentally.

Eastern California: Under "*chrysotheme*, yellow race," Hovanitz (1943) lumps together the series of diverse geographical races which I have called (Gerould, 1943) the "*eriphyle-philodice* complex," extending from Alberta across the continent to Maine. Presumably derived by ancient mutations from the now highly heterozygous *eurytheme* of the extreme northwest and eastern California, this series in the Rocky Mountains exhibits in the female a succession of variations showing a gradual loss of orange. Eastward from the Rockies, it becomes the clear sulphur-yellow *philodice* of the central and eastern States.

In eastern California Hovanitz (1943) found about 10% of natural hybrids between *eriphyle* and *eurytheme* at a locality where both occur simultaneously (Round Valley, about 50 miles southeast of Yosemite). At a higher elevation 50 miles away (Mono Lake), *eurytheme* occurs continuously throughout the summer but the generations of the rarer *eriphyle* are separated by interbrood periods (as in June) with no adults. No data on hybridization there were published. At Round Valley, however, during two summers when large numbers of both were observed, *eriphyle* was usually slightly in excess (65%) and, as is common in *Colias*, there was a large excess of males. The percentage of hybrids was smallest, 6.08%, when the observed number was greatest, 575, but 10% seems to be a fair average.

Hovanitz notes that the "two races have maintained their primary discreteness" notwithstanding long interbreeding. If hybridization were "only of very recent origin," he would expect a higher frequency of F_1 than of other (backcross) intermediates. This appears from the histogram to be the case only in the male, in which tendency to a trimodal curve is shown, whereas in the female the curve is U-shaped with a hollow where F_1 would be. To explain this "lack of the F_1 intermediates" in the female, "a general lower viability seems to be the most likely."

He kindly sent me for examination from Round Valley, June, 1941, 11 *eurytheme*, 22 *eriphyle*, and 6 hybrid, *males;* also 2 typical *eurytheme*

(one, pale) and 5 *eriphyle, females*, but no recognizable ♀ hybrids. Hybridity of the 6 males seems certain, for in pure *eriphyle* broods from various localities I have found that the males are constantly clear yellow. Two of the 6 hybrid males were apparently F_1 of *eurytheme* × *eriphyle;* four were paler, evidently of a backcross to *eriphyle.*

SUMMARY

Population percentages of bright-orange *Colias eurytheme* Boisduval, plus pale-orange hybrids, in territory long occupied by the clear-yellow *C. philodice* Godart, increased between 1940 and 1943 six-fold, i.e., from 1.5±0.5 percent (n=658) in 1940 to 9.2±0.7% (n=1852) in 1943. Meanwhile, the proportion of hybrids to pure *eurytheme* apparently decreased from around 50% (n=10) to 7.0 (n=171). But in 1940 only 1 *eurytheme* ♀ was taken (with 4 ♂♂ and 5 hybrid ♂♂). In 1943, however, 42 pure *eurytheme* females (5.7% of the whole *Colias* female population-sample examined) were captured, with 117 *eurytheme* males, so that these were able to mate within their own species. One such couple was caught; and no cross-mating was observed. (See also Gerould, 1943, p. 408.) In 1945, the foreign *Colias* population (i.e., *eurytheme*+hybrids) observed in a much smaller sample (301) was 24, or 8. %, nearly equal to the 9. % taken in 1943, but the percent of hybrids to pure *eurytheme* had increased to several times the 7. % of 1943, viz., to around 20. %, though only 19 *eurytheme* and 5 hybrids were taken.

However, the percent of hybrids in the whole *Colias* population-sample in 1940 and again in 1943 was less than 1. %; in 1945 it was approximately 1.5%. These figures may be compared with the 10. % of *eurytheme*×*eriphyle* hybrids taken by Hovanitz (1943) at one locality in eastern California.

In 1940, 17.2±2.4% (n=244) of captured *philodice* females were white, and no white *eurytheme* was taken. In 1943, 23.4±1.6% (n=689) of the *philodice* females, as determined by the color pattern, were white, and 16.7±5.7% (n=42) of *eurytheme* females were white. Combining both species, 22.9±1.5% (n=734) of all females were white. In 1945, the 26 white females taken were all *philodice*, i.e., 21.0±3.7% of the 124 ♀ ♀ taken.

Upper-surface color-pattern differences between the females of *eurytheme* and *philodice* are described and illustrated. Though most white females can be readily distinguished as *eurytheme* or as *philodice*, others, of intermediate color-pattern, are difficult to classify with as much accuracy as is possible in distinguishing and classifying the males and "colored" females as *eurytheme, philodice* or hybrid. "Colored" hybrids of the backcross to *eurytheme* are also difficult to distinguish from members of that "species" of definite purity (homozygosity), so that one is strongly inclined to lump them under one species name.

The use of "*Colias chrysotheme* Esper," however, to cover *C. eurytheme, C. philodice* and their hybrids is based on slight evidence. It is likely, in my opinion, to confuse, rather than promote, taxonomy and genetics.

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COMMON INSECTS OF HAWAII, by DAVID T. FULLAWAY and NOEL L. H. KRAUSS. 228 pages, 16 text figures, 12 colored plates, 1945. Tongg Publishing Company, Honolulu. Price $3.50.

The work and expense involved in the production of a book illustrated in color should result in a volume worthy of unstinted praise, but this one, unfortunately, leaves the reviewer with mixed impressions. Its purpose is indicated in the preface as just what the title suggests, but with the further statement that "it is definitely not another Fauna Hawaiiensis, but rather a cross-section of the lowland fauna." Further the preface states that many of the common economic insects have been omitted to conserve space. These statements raise a question as to the exact purpose of the book, particularly when its organization is considered.

Passing on to the first chapter one finds an elementary description of insect morphology and metamorphosis. The remainder consists of eight chapters dealing with various orders of insects and a final chapter on arthropods of other orders. Three hundred fifty-seven serially numbered species are considered, the treatment varying from a few lines on habitat, distribution and distinctive characters to more than a page, including life history. No discussion of the classification and no keys are included.

The conclusion is inevitable that the value of the book to the amateur is limited by the omission of aids to identification and for the trained entomologist who does not need such aids its scope seems also a limitation. With colored illustrations it may be a valuable aid to quick identification of many species, but here again a limitation is encountered in the quality of the plates. Evidently the original drawings were excellent and the four-color process used in reproduction should have been adequate, but in the reviewer's copy the several impressions are out of register on most of the plates and on some to a degree which is very trying to the eyes. It is unfortunate that the printers failed to do justice to their copy.

The reviewer is not familiar with the Hawaiian fauna, hence he can only guess that closely related species whose separation is difficult are not numerous. If this is the case, the book may well serve as a helpful manual within its avowed scope.—A. W. L.

NORTH AMERICAN SPECIES OF THE GENUS HOPLISMENUS[1]

(Hymenoptera: Ichneumonidae)

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This paper includes the species of *Hoplismenus* occurring in the United States and Canada. Seven species are here recognized, three of which are new. Three additional forms, one new, are given subspecific rank.

Material for this study was obtained from the following collections: United States National Museum (US), Academy of Natural Sciences of Philadelphia (ANSP), Cornell University (CU), Oregon State College (Ore), University of Minnesota, Canadian National Collection (CNC), The Iowa Insect Survey Collection, The Townes Collection (Tow), the collection of R. T. Mitchell, and the collection of the author (Sw). The abbreviations after the names above are those used in the following pages. To the various persons in charge of the collections who generously supplied material the writer expresses his appreciation.

Genus **Hoplismenus** Gravenhorst

Hoplismenus Gravenhorst, Ichneum. Europeae, 1829, 2: 409.

Genotype: (*Hoplismenus maestus* Gravenhorst) = *armatorious* Panzer.

Scutellum usually strongly convex; propodeum with a pair of prominent dorsolateral spines; second abdominal tergite heavily punctured, polished or mat; gastrocoeli transverse, 0.2 to 0.4 the width of the abdomen, depressed, the depressed portion sculptured; postpetiole rugulose, irregularly striate or punctate, its surface either polished or mat; temples viewed from above receding, straight or moderately curved; clypeus typically convex, punctate and rather narrow, but in *propitius* and *teres* flattened, polished and rather broad; legs and antennae long and slender, the latter attenuate at apex, the first flagellar segment in the female at least four times as long as broad. A general idea of the habitus of the genus may be gained from Figure 1.

Gravenhorst proposed the genus *Hoplismenus* to include those species with an elevated scutellum, two propodeal spines, and oblong, petiolate abdomen, pentangular areolet, and slender legs and antennae. Because of superficial similarities several Platylabini have been assigned to *Hoplismenus* in the past. Cresson[2] first recognized the genus in this country as represented by *morulus* (Say).

The generic limits of *Hoplismenus* are not completely defined, and the inclusion here of *scutellatus*, *propitius*, and *teres* may be open to

[1]The writer wishes to express his appreciation to Dr. Henry K. Townes for the assistance generously given during the preparation of this paper.

[2]Cresson, E. T. 1868. *Trans. Amer. Ent. Soc.*, 2: 89.

question. The final decision as to generic boundaries must await more careful study, particularly of the many species of ***Hoplismenus*** and related genera in the tropical fauna. The genus ***Peritaenius*** Förster is applied by Clément to those species of ***Hoplismenus*** with the scutellum transversely carinate at the apex.[3] If this genus is valid, ***scutellatus*** apparently should be assigned to it. None of the species placed in ***Peritaenius*** by Clément, however, have been seen by the author, and in the absence of definite evidence it seems best to keep ***scutellatus*** in ***Hoplismenus***. There is much variation in the scutellum among the species of ***Hoplismenus*** and related genera. The transversely carinate scutellum exists in varying degrees of prominence from the weakly tectiform shape present in the European ***perniciosus*** Grav. to the strongly margined scutellum of ***scutellatus***. Its importance as a primary generic character thus appears doubtful.

Largely because of its flat, expanded clypeus and weakly convex scutellum ***propitius*** has not been included in ***Hoplismenus*** in the past. But ***propitius***, and hence also ***teres***, is more closely related to typical ***Hoplismenus*** than to any other genus known to the author, and does not seem distinct enough to warrant the erection of a new genus.

Kreichbaumer,[4] Schmeideknecht,[5] and Townes[6] have considered the genus ***Rhysaspis*** Tischbein a synonym of ***Hoplismenus***. Clément[7] considers ***Rhysaspis*** distinct, containing the European species ***rugosus*** Tisch. and ***kreichbaumeri*** Clement. Neither of these species is available to the author for study, and thus the synonymy cannot be reviewed at this time. Heinrich[8] states that the genotype of ***Xanthojoppa*** Cameron, ***X. nigrolineata*** Cam., belongs in ***Hoplismenus***. Specimens of this species have not been seen by the author and the synonymy of ***Xanthojoppa*** with ***Hoplismenus*** cannot be confirmed here.

The genus ***Hoplismenus*** is world wide in distribution. Schmiedeknecht[9] lists 10 species for Europe and Uchida[10] lists 8 as occurring in Japan. Della Torre in his *Catalogus Hymenopterorum* mentions 35 species as placed in ***Hoplismenus*** up to 1901,[11] and about that number of additional species have been described since then. Several of these are undoubtedly misplaced Platylabini or species belonging to other amblyteline genera. The author has seen about 20 species of ***Hoplismenus***, for the most part undescribed, from Central and South America, Africa, and China.

All North American host records are in the Nymphalidae. Other records belong predominantly in that family but also in the Pieridae, Phalaenidae, and possibly others. In all cases known to the writer the adult parasite emerges from the host chrysalis.

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[3]Clément, Von E. 1927. *Konowia*, 6: 74.
[4]Kreichbaumer, J. 1894. *Entom. Nachrichten*, p. 347.
[5]Schmeideknecht, O. 1903. *Opuscula Ichneumonologica*, Blankenburg, p. 202.
[6]Townes, H. K. 1944. *Mem. Amer. Ent. Soc.*, 11: 319.
[7]Clément, Von E. 1927. *Konowia*, 6: 65.
[8]Heinrich, G. 1933. *Mitt. Zool. Mus. Berlin*, 19: 164.
[9]Schmeideknecht, O. *Op. cit.*, p. 202.
[10]Uchida, T. 1926. *Journ. Coll. Agri. Hokkaido Imperial Univ.*, Sapporo, Japan, 18: 68.
[11]Dalla Torre, K. 1901. *Catalogus Hymenopterorum*, Leipzig, 3: 1024.

A KEY TO THE NEARCTIC SPECIES OF HOPLISMENUS

1. Thorax and abdomen black except for occasional marks on scutellum, subtegular ridge,[12] and apices of abdominal tergites; wings blackish; face and clypeus strongly punctate.....(1. **morulus**) 2
   Thorax or abdomen at least in part ferruginous or reddish; wings hyaline or subhyaline.....4
2. Hind femur ferruginous to stramineous. (California, Oregon, Washington, and British Columbia).....1b. **morulus pacificus**
   Hind femur black or blackish, occasionally pale at apex.....3
3. Hind tibia yellowish. (Eastern and central United States and Canada), 1a. **morulus morulus**
   Hind tibia at least in part black or blackish. (Colorado, Utah, and New Mexico).....1c. **morulus flavitarsis**
4. Scutellum elevated apically into a subacute, transverse carina; propodeal carinae regular and well marked; tarsi yellowish white.....3. **scutellatus**
   Scutellum rounded, without an apical, subacute transverse carina.....5
5. Thorax black. (Figure 1).....2. **arizonensis**
   Thorax mostly reddish.....6
6. Clypeus convex, opaque, and strongly punctate; second abdominal tergite not piceous at apex.....7
   Clypeus flat or very weakly convex, polished, impunctate or very weakly punctate; second abdominal tergite more or less piceous at apex.....9
7. Eye margined with white posteriorly; postpetiole as closely punctate as the second tergite (Figure 6); mesoplerum opaque, closely punctate, the punctures nowhere separated by their own width.....5. **praeruptus**
   Eye not margined with white posteriorly; postpetiole mat, with a few scattered punctures, never as closely punctate as the second tergite (Figure 7); mesopleurum polished, the punctures separated in some areas by at least their own width.....(4. **rutilus**) 8
8. Antennal annulus usually on flagellar segments 6 to 11; hind basitarsus more or less piceous, the remaining tarsal joints yellowish. (Northeastern United States).....4a. **rutilus rutilus**
   Antennal annulus only on flagellar segments 8 to 10; hind tarsus with the second joint usually piceous as the first, the apical joints more or less ferruginous. (Colorado, Wyoming, and Oregon).....4b. **rutilus tenuis**
9. Clypeus with the lateral margins parallel, the apical corners approaching right angles, the apical margin often slightly reflexed (Figures 4 and 5); male with tyloids[13] broad and distinct; female with cheeks on anterior view distinctly convex.....6. **propitius**
   Clypeus with the lateral margins converging, the apical corners broadly rounded (Figures 2 and 3); male with tyloids linear, often indistinct; female with cheeks on anterior view very weakly convex.....7. **teres**

1. Hoplismenus morulus (Say)

Three nearctic subspecies are considered here under *morulus*. The form *morulus* represents the species in the eastern and central United States and Canada, the westernmost records being Colorado and Alberta; *flavitarsis* occurs in Colorado, Utah, and New Mexico, and *pacificus* in California, Oregon, Washington, and British Columbia. No differences in structure between these forms were found, and they thus seem to constitute one polytypic species. No specimens have been seen that could be considered as intergrades.

[12]The term *subtegular ridge*, as used here and in the following pages, refers to the sharp ridge that projects laterally from the dorsal margin of the mesopleurum immediately below the tegula.

[13]The term *tyloids* as used here applies to elongate, raised and polished areas on the posterolateral face of the male flagellum. They occur on each of several median and postmedian segments.

It is interesting to note that the difference in color pattern between the subspecies ***morulus*** and ***pacificus***, namely, the change from yellow and black leg color to dull reddish or piceous, is paralleled by a few other ichneumons not necessarily closely related. For example, in the northwestern race of *Exetastes bituminosus* Cush. the legs are darker than in the east and the antennal annulus, present in eastern specimens, is lacking. In *Rhembobius abdominalis* (Prov.) the eastern form with red and black hind legs is replaced in the west by a race in which the hind legs are an even dull reddish.

The concept of ***Hoplismenus morulus*** should possibly be expanded to include non-nearctic subspecies. The author has seen two specimens of ***Hoplismenus terrificus*** Wesmael from Switzerland in the United States National Museum. This form is extremely close to ***morulus*** although more specimens must be examined before ***terrificus*** can definitely be considered as another subspecies. *H. lamprolabus* Wesmael, a closely related European form, is a distinct species, differentiated by shorter antennae, smaller gastrocoeli, more polished abdominal tergites, and a larger scutellum.

1a. Hoplismenus morulus morulus (Say)

Ichneumon morulus Say, Contrib. Maclurean Lyceum Arts Sci., 1829, 1: 73 (Leconte Ed., 1:377), female.
Hoplismenus morulus Cresson, Trans. Amer. Ent. Soc., 1868, 2: 89.
Ichneumon calacratus Provancher, Nat. Canad., 1875, 7: 21, 49, male.
Hoplismenus morulus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 186, male, female.
Hoplismenus morulus Provancher, Nat. Canad., 1879, 11: 2 (Faunae, p. 291).
Hoplismenus morulus var. *morulus* Townes, Mem. Amer. Ent. Soc., 1944, 11: 319.

Only the more important taxonomic references are listed here. For a complete bibliography of the species the reader is referred to the last reference given above.

Female.—Length 11–18 mm. Black except as follows: all tibiae and tarsi, often apices of the femora, and usually the inside margin of the eye deep yellowish; antennal annulus white or light yellow, beginning on flagellar segments 5 to 7 and ending on segments 13 to 16; femora, flagellar segments, and apices of abdominal tergites occasionally dark reddish or dark stramineous; wings blackish.

Clypeus punctate, polished, truncate or slightly rounded at the apex, strongly convex, viewed from the side meeting the labrum in approximately a right angle; face strongly punctate, more or less mat, elongate, with a median swelling that is continuous on to the clypeus; temples viewed from above strongly receding, the sides straight; occipital carina prominent; thorax coarsely punctate, more or less mat, the mesoscutum often rugose in the region of the notaulus; scutellum punctate, polished, subpyramidal; propodeum with many large, irregular rugae and a pair of prominent dorsolateral spines; propodeal carinae irregular but usually distinct; petiole square in cross section, the dorsal surface smooth and polished, the lateral and ventral surfaces with large, regular, transverse rugae; postpetiole polished, rugulose, occasionally with a few scattered punctures; gastrocoelus impressed, 0.3 to 0.4 the width of the abdomen; second abdominal tergite strongly punctate, weakly mat; legs long and slender; antenna slender, attenuate

at the apex, the first flagellar segment slightly more than four times as long as broad at base.

Male.—Black except as follows: face and clypeus, except occasionally for median dark markings, scape below, usually a mark on the scutellum and subtegular ridge light yellow; flagellar segments below, all tibiae and tarsi, front femur, all or most of middle femur, apex of hind femur, and all or some of the front and middle trochanters deep yellowish; wings blackish.

Structure similar to the female except as follows: clypeus somewhat less convex; first flagellar segment about three times as long as broad at base; tyloids elongate-oval, beginning on flagellar segments 7 to 9, ending on segments 19 to 21.

The type of ***morulus*** has been destroyed; the type of ***calcaratus*** is in the Museum of the Province of Quebec, at Quebec.

Material: 147 females and 20 males from Massachusetts (Cambridge); Connecticut; New York (Ithaca, Bemus Point); New Jersey (Moorestown); Pennsylvania (Valley Forge, North Cumberland, Linglestown, Roberts P. O.); Maryland (Bowie, Plummers Island); Ohio (Champaign Co., Put-in-Bay); Indiana (Elkhart); West Virginia (Bolivar); Virginia (near Plummers Island); north Illinois; Michigan (Ann Arbor); Wisconsin (Sawyer Co.); Minnesota (Dakota Co., Rice Co., Hennepin Co., Mille Lacs Co., Case Co., St. Peter, Garrison, Itasca Park, Mille Lacs Lake); Iowa (Louisa Co., Jefferson Co., Henry Co., Des Moines Co., Linn Co., Crawford Co., Mt. Vernon, Iowa City, Coralville, Davenport, Mt. Pleasant, Anamosa, Ames); Kansas (Onaga); Prince Edward Island (Brackley Beach in the Canadian National Park); Ontario (Ottawa, Toronto, Orillia Co., Hastings, Georgetown, Constance Bay, Point Pelee); Quebec (Queens Park in Alymer, Hull, Meach Lake, Kingsmere, Covey Hill). Additional records in literature are from Maine, Colorado, and Bilby, Alberta.

This subspecies has been reared from ***Nymphalis antiopa*** (L.) (the mourning cloak butterfly),[14] and also from ***Polygonia interrogationis*** (Fab.) (the question mark).[15] Included in the material at hand are two specimens reared from ***Vanessa*** sp. presumably ***cardui*** (L.) (the painted lady).[16] One of these, a male, bears the label "Ithaca, N. Y., VIII–16–1885" (CU); the other, a female, was reared by R. T. Mitchell at Bowie, Md., X–9–1944 (Sw.). According to Schaffner and Griswold, ***morulus*** has two or more generations a year.

This is a species of mesic woods, particularly common along wooded streams and river margins where there is a leafy urticaceous undergrowth. Regions abundant in such plants as ***Pilea*** (clearweed) and ***Laportea*** (nettles), upon which the host caterpillars feed, will frequently yield specimens. The greater part of the material examined was collected in the summer months, but ***morulus*** has been taken in every month of the year.

This subspecies may be readily distinguished in eastern North America by the characters of the species, namely the large, all black

[14]Howard *in* Scudder. 1889. *Butterflies of Eastern U. S. and Canada*, 3: 1878.
[15]Schaffner and Griswold. 1934. *Misc. Pub. U. S. Dept. Agr.*, 188: 141.
[16]The author is indebted to Mr. Carl Heinrich of the United States National Museum for this determinalion.

body, blackish wings, and peculiarly elongated face. It may be distinguished from the two subspecies that replace it in western North America by the deep yellow hind tibia. In *pacificus* the hind tibia is reddish at the base and often piceous at the apex; in *flavitarsis* the hind tibia is at least in part blackish or piceous.

1b. Hoplismenus morulus flavitarsis (Cresson)

Trogus flavitarsis Cresson, Proc. Ent. Soc. Phila., 1865, 4: 265, male.
Hoplismenus flavitarsis Cresson, Trans. Amer. Ent. Soc., 1868, 2: 89.
Hoplismenus flavitarsis Cresson, Trans. Amer. Ent. Soc., 1877, 6: 185.
Hoplismenus morulus var. *flavitarsis* Viereck, Trans. Amer., Ent. Soc., 1903, 29, 75.
Hoplismenus morulus var. *flavitarsis* Townes, Mem. Amer. Ent. Soc., 1944, 11: 320.

Female.—Black except as follows: front and middle tibiae, all tarsi, and occasionally a stripe on anterior margin of hind tibia deep yellowish; other parts of legs black to more or less dark reddish or dark stramineous; middle tibia and hind basitarsus sometimes dark; a light yellow to white annulus on flagellar segments 6 or 7 to 12 or 13.

Structure as in *morulus morulus*.

Male.—Black except as follows: face and clypeus, except for small median dark markings, and a mark on the scape below white; all tarsi, front and middle tibiae, and front femur at apex light yellow; front and middle femora, and hind tibia stramineous piceous, the hind tibia with a light stripe on the anterior face; apices of abdominal tergites dark reddish; flagellum deep yellowish below.

Structure as in *morulus morulus*.

The description of the male above was taken from the type in the Academy of Natural Sciences of Philadelphia.

Material: 8 females and 1 male. Three females, Colorado (US); 2 females, Colorado (ANSP); male, *type*, Colorado (ANSP); female, Garden of the Gods, Colorado (US); female, Beulah, New Mexico, VIII–17–1901, H. Skinner (ANSP); female, Farmington, Utah, "June-July" 1944, G. S. Bohart (Tow).

1c. Hoplismenus morulus pacificus Cresson

Hoplismenus pacificus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 186, male, female.
Hoplismenus pacificus Cresson, Proc. Acad. Nat. Sci. Phila., 1878, p. 354.
Hoplismenus pacificus Townes, Mem. Amer. Ent. Soc., 1944, 11: 320.

Female.—Black except as follows: all legs including coxae, the scape below, occasional marks on clypeus and lateral margins of face ferruginous; apical end of hind tibia, and often the basal half of hind basitarsus dark reddish to piceous; apical 4 joints of hind tarsus occasionally light yellow; a light yellow to white annulus beginning on flagellar segments 5 to 7, ending on segments 11 to 13; apical antennal

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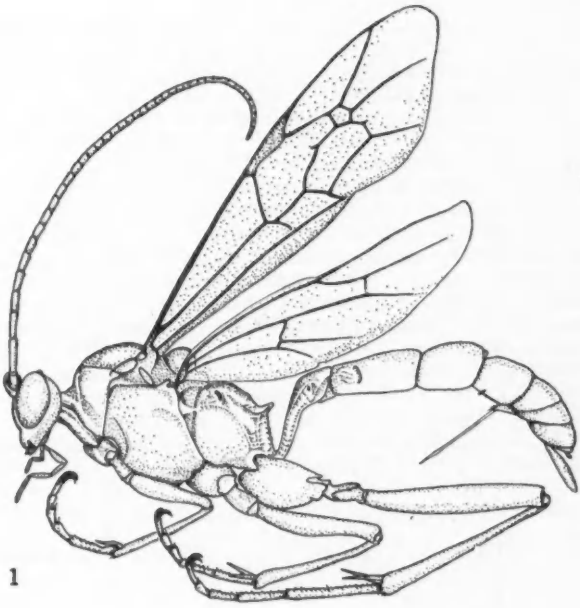
EXPLANATION OF PLATE

1. *Hoplismenus arizonensis*. 2. *Hoplismenus teres*, male. 3. *Hoplismenus teres*, female. 4. *Hoplismenus propitius*, male. 5. *Hoplismenus propitius*, female. 6. *Hoplismenus praeruptus*, postpetiole, dorsal view. 7. *Hoplismenus rutilus*, postpetiole, dorsal view. 8. *Hoplismenus praeruptus*, scutellum, lateral view. 9. *Hoplismenus rutilis*, scutellum, lateral view.



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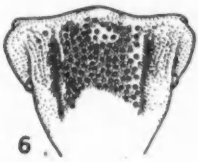

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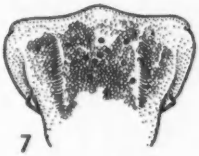

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segments often lighter below; apices of abdominal tergites occasionally dark reddish.

Structure as in ***morulus morulus***.

Male.—Black except as follows: face, clypeus, and the scape below variously marked with black, ferruginous, and light yellowish or white; flagellar segments below often dull yellowish; all legs, including the coxae, ferruginous to yellowish, with the coxae, trochanters, and apex of the hind tibia often marked with piceous; abdominal tergites, particularly at the apices, occasionally dark reddish or dark stramineous.

Structure as in ***morulus morulus***.

The type, a female from Vancouver Island, British Columbia, is in the Academy of Natural Sciences of Philadelphia.

Material: 38 females and 7 males from California (Guerneville in Sonoma Co., Mesa Grande in Sonoma Co., Fort Seward, Blocksburg); Oregon (Vida, Portland, Gold Beach, 2 miles west of Paulina Lake); Washington (Forks in Clallam Co., North Bend in King Co., Elbe, Pullman, Hamma Hamma, Easton, Tieton); British Columbia (Robson, Wellington, Nanaimo, Victoria, Oliver, Agassiz, Clinton, Osoyoos, Vancouver, Kaslo, Field Rocky Mountains at 4800 feet).

Included in the material at hand are two females reared from *Nymphalis californica* (Bdv.) (the California tortoise-shell). They are labeled "Hamma Hamma, Wn., VI–27–1935, ex Aglais californica, R. L. Furniss, Hopk., US 31,650-B" (US).

2. **Hoplismenus arizonensis** n. sp.

Female.—(Figure 1). Length 13 mm. Head and thorax black except as follows: lateral margins of face, a mark on the anterior margin of pronotum, a small spot on the subtegular ridge, and a mark on the scutellum yellowish white; legs and abdomen uniformly reddish except as follows: front and middle coxae and trochanters, and the petiole at base faintly marked with piceous; front tibia with a pale stripe on the anterior margin; ovipositor sheath reddish, the apex black; antenna black, a pale annulus on flagellar segments 8 to 14; wings subhyaline, veins dark brown, a pale spot at base of stigma.

Face and clypeus heavily punctured, the clypeus strongly convex, weakly mat; temples viewed from above straight, strongly receding, on lateral view only half as wide as the eyes, scutellum polished, heavily punctured, less elevated than in ***morulus***, carinate to middle, the sides almost vertical; propodeum rugose, the carinae weak in the region of the areola, the petiolar area wide; propodeal spines long and narrow; petiole above punctate toward apex; postpetiole polished, rugulose punctate; gastrocoelus about 0.3 the width of the abdomen; second and third tergites heavily punctured, mat.

Male.—Unknown.

Known only from the type specimen, which bears the label "Santa Catalina Mts., Arizona, VI–30, M. Cazier." It is in the United States National Museum.

H. arizonensis and ***scutellatus*** can be distinguished from the other forms described here by the all or largely reddish abdomen. ***H. arizonensis*** differs from ***scutellatus*** in the evenly convex scutellum, not

transversely carinate, the weakly carinate propodeum, narrow propodeal spines, and in the closely punctate, opaque episternum and metapleurum.

3. Hoplismenus scutellatus (Provancher)

Ichneumon scutellatus Provancher, Nat. Canad., 1875, 7: 24, 78, male, female.
Hoplismenus scutellatus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 186, male.
Hoplismenus scutellatus Provancher, Nat. Canad., 1879, 11: 3, (Faune, p. 291).
Hoplismenus transversus Davis, Trans. Amer. Ent. Soc., 1898, 24: 351, male.
Hoplismenus scutellatus Townes, Mem. Amer. Ent. Soc., 1944, 11: 321.

Male.—Length 10 mm. Head black except as follows: face, clypeus, and the margin of cheek behind the eye white; thorax black or piceous, the mesoscutum black or marked with reddish; a mark on the subtegular ridge, a mark on the posterior pronotal margin near tegula, anterior margin of pronotum, and a mark on the scutellum white; tegula white or piceous; abdominal tergites 1 to 3 reddish, the remainder reddish or black; all tarsi, front and middle tibiae, anterior margin of front and middle femora, and marks on front and middle coxae yellowish white; all coxae, hind trochanter, tibia and basitarsus marked with piceous; the remaining parts of legs ferruginous; antenna dark above, deep yellowish below; wings hyaline.

Temples viewed from above rather strongly receding, weakly curved; episternum and metapleurum polished, punctate; scutellum with the lateral carinae extending to the middle, continuous with an apical transverse carina; posterior face of scutellum also bordered by carinae, the sides nearly vertical; propodeum with strong, regular carinae, the petiolar area concave, weakly transversely rugose, polished; postpetiole weakly mat, with a few scattered punctures; gastrocoelus 0.3 the width of the abdomen; second and third abdominal tergites punctate-mat.

Female.—Provancher, in the original description, states that the female is colored exactly as the male except for the antennae.

The type of *scutellatus* is in the Museum of the Province of Quebec, at Quebec. The type of *transversus* is in the Academy of Natural Sciences of Philadelphia.

The above description was taken from two males, both in the Academy of Natural Sciences of Philadelphia. One, the type of *transversus*, Moscow, Idaho, J. M. Aldrich, has an all red abdomen and partially reddish thorax. The other is a much battered specimen, bearing only the label "Can," probably sent to Cresson by Provancher from the original type series. This specimen has a black thorax and abdominal tergites 4 to the apex black. In spite of the difference in color the author agrees with Townes that *transversus* and *scutellatus* are synonymous.

This is a rare species, apparently represented only by the type material of Provancher, two males and one female, and the male type of *transversus*.

4. Hoplismensus rutilus (Cresson)

Under *rutilus* two subspecies are included. In the material studied the form *rutilus rutilus* is represented from the northeastern United

States. The subspecies *rutilus tenuis* is represented from Colorado, Oregon and Wyoming.

4a. Hoplismenus rutilus rutilus (Cresson)

Ichneumon rutilus Cresson, Proc. Ent. Soc. Phila., 1864, 3: 169, female.
Ichneumon? rutilus Cresson, Trans. Amer. Ent. Soc., 1877, 6: 185, female.
Hoplismenus rutilus Johnson, Biol. Surv. Mt. Desert Region, 1927, 1: 146.
Hoplismenus rutilus Cushman, Proc. U. S. Nat. Mus., 1933, 82: 1.
Hoplismenus rutilus Townes, Mem. Amer. Ent. Soc., 1944, 11: 321 (in part).

Female.—(Figures 7 and 9). Length 10 to 12 mm. Ferruginous except as follows: clypeus, marks on posterior surface of head, pronotum, lateral cervicals, prepectus, region between the scutellum and wing bases, parts of the mesosternum, metapleurum and metasternum often more or less black or piceous; lateral margins of face, anterior margin of pronotum, a mark on the posterior pronotal margin near tegula, subtegular ridge, scutellum, and occasionally the propodeal spines more or less white or light yellow; legs ferruginous except as follows: 4 apical segments of hind tarsus, and a stripe on the anterior face of front tibia usually yellowish; hind basitarsus and apical third of hind tibia piceous; scape ferruginous, occasionally black above; first 5 flagellar segments ferruginous variously marked with black at apex above; antennal annulus usually on flagellar segments 6 to 11; wings faintly brownish yellow, the veins light brown or brown.

Clypeus convex, punctate, opaque; temples viewed from above almost straight; eye 1.1 to 1.4 as wide as cheek[17] malar space 1.6 to 1.8 mandible width at base; mesopleurum polished, the punctures in some regions separated by at least their own width; scutellum polished, weakly punctate, evenly convex on lateral view; metapleural carina distinct, usually complete; postpetiole mat, weakly punctate, never as closely punctate as the second tergite, usually with less than 30 punctures in the median area posterior to the spiracles; gastrocoelus about 0.3 the width of abdomen.

Male.—Unknown. Males of *H. teres* have previously been assigned to this species.

The type, labeled only "Va.," is in the Academy of Natural Sciences of Philadelphia.

Material: 5 females. Winchendon, Massachusetts, VII–1–1892 (Sw); Westerly, Rhode Island, VII–5–1936, M. Chapman (Tow); Lyme, Connecticut, VI–18–1918, Wm. Middleton (US); Wilawana, Pennsylvania, VII–12–1938, R. N. Crandall (Tow); type, Virginia (ANSP).

Three species have previously been confused in collections under *rutilus*. The females placed under *rutilus* in the past are here divided into *rutilus* and *praeruptus*, and the males are placed in *teres*.

H. rutilus is rare and poorly represented in collections. This and the following species are differentiated as the only predominantly red members of the genus in the nearctic region with a convex, punctate and opaque clypeus. The species is close to *praeruptus* but is readily distinguished by the characters listed under that species.

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[17]This ratio was measured from a lateral view, across the greatest width of the eye, perpendicular to the posterior eye margin.

4b. Hoplismenus rutilus tenuis n. subsp.

Female.—Differs from *rutilus rutilus* only as follows: size smaller, length 7 to 10 mm.; antennal annulus on flagellar segments 8 to 10 only, usually incomplete; hind tarsus ferruginous, the basitarsus and subsequent joints more or less piceous; light areas reduced or wanting, the light lateral margin of the face reduced to a small spot above the level of the antenna, the light mark on the scutellum wanting except in the Wyoming specimen which has a small light spot in the center; black or piceous areas reduced or wanting, the clypeus, lateral cervicals, and pronotum ferruginous. Wing and vein color as in *rutilus rutilus* except for the Woming specimen, which has wings slightly more hyaline and the veins dark brown.

Male.—Unknown.

The type is deposited in the United States National Museum.

Material: 5 females. *Type*, Twin Sisters, Colorado, "Canadian Zone," VII–23, C. K. W. (US). *Paratypes*, Gregory Canyon, Boulder, Colorado, VIII–2–1916, L. O. Jackson (Sw); Corvallis, Oregon, V–10–1929 (Ore); Corvallis, Oregon (US); Grand Teton National Park, Wyoming, VII–14–1939 (Tow).

5. Hoplismenus praeruptus n. sp.

Female.—(Figures 6 and 8). Length 9 to 11 mm. Color as in *rutilus* except as follows: clypeus ferruginous; eye margined with white posteriorly; scutellum with a light mark only in center; hind tarsus entirely ferruginous; fore coxa white in front, the middle coxa with a small white spot; flagellar segments below the annulus uniformly black or piceous; wings faintly brownish, the veins dark brown.

Similar in structure to *rutilus* except as follows: eye 1.5 to 1.6 as wide as cheek; malar space 1.2 to 1.4 mandible width at base; mesopleurum closely punctate, opaque, the punctures nowhere separated by their own width; scutellum elevated, cuboidal; metapleural carina poorly defined, incomplete; postpetiole closely punctate, as much so as the second tergite.

Male.—Unknown.

The type is in the United States National Museum.

Material: 6 females. *Type*, Six Mile Creek, Ithaca, New York, IX–16–1939, P. P. Baiby (US). *Paratypes*, Ithaca, New York, V–9–1936, H. K. Townes (Tow); Connecticut (Sw); Olympia, Washington (US); "13–5," W. H. Harrington Collection (CNC); F. P. Atkinson (ANSP).

The Townes specimen was also taken in the type locality, Six Mile Creek, Ithaca, New York. This is a moist, wooded stream bed area, similar to the habitat preferred by *morulus morulus*.

6. Hoplismenus propitius (Cresson)

Ichneumon propitius Cresson, Trans. Amer. Ent. Soc., 1872, 4: 156, male.
Ichneumon propitius Cresson, Trans. Amer. Ent. Soc., 1877, 6: 182.
Ichneumon tharotis Packard, Proc. Boston Soc. Nat. Hist., 1881, 21: 22, female.
Ichneumon instabilis Howard, *in* Scudder, Butterflies of Eastern U. S. and Canada, 1889, 3: 1876 (misdetermined in part).
Amblyteles propitius Cushman, Proc. U. S. Nat. Mus., 1933, 82: 1.

Amblyteles propitius Schaffner and Griswold, Misc. Pub. U. S. Dept. Agr., 1934, 188: 139.
Amblyteles propitius Brimley, Insects of North Carolina, 1938, p. 405.
Hoplismenus propitius Townes, Mem. Amer. Ent. Soc., 1944, 11: 320.

Female.—(Figure 5). Length 8 to 11 mm. Ferruginous except as follows: parts of the lateral cervical and prepectus, region between the scutellum and wing bases, occasionally the pleural and mesonotal sutures, often parts of the metapleurum and metasternum, and the petiolar tergite and sternite at base piceous or black; sutures of abdominal tergites, hind tarsus, and apices of hind femur and tibia more or less infuscated; scutellum and a mark on the subtegular ridge usually yellow; antenna darker above, ferruginous below, a pale annulus usually on flagellar segments 6 or 7 to 12; wings very slightly dusky, veins brown, the stigma with a pale spot at base. An occasional specimen may be almost completely ferruginous.

Face weakly punctate, weakly mat; clypeus expanded, polished, usually impunctate, the apical margin usually weakly rounded and slightly reflexed; sides of clypeus parallel, making approximately a right angle with the apical margin; mandibles strap-like, not twisted, the smaller tooth arising not or very slightly dorsad of the larger, often expanded near the apex, the shorter tooth usually as wide or wider than the longer at base, the teeth unequal in length by a distance approximately the width of the longer at base; cheeks viewed from in front slightly curved in outline; temples viewed from above moderately receding, rounded; scutellum moderately convex, low for the genus, polished and punctate; propodeal spiracles short oval to oval; propodeal spines short; postpetiole polished, often with a few punctures, usually weakly longitudinally striate, but occasionally finely rugulose; gastrocoelus strongly impressed, rugose, about 0.3 the width of the abdomen; second and third tergites strongly punctured, usually polished except at the apices which are weakly mat.

Male.—(Figure 4). Similar to the female except as follows: face, clypeus, the scape below, portions of front and middle trochanters, hind tibia at base, basal three joints of middle and hind tarsi, anterior margin of pronotum, and a spot on the subtegular ridge yellow or yellowish; antenna yellowish below, dark above, a yellow annulus on flagellar segments 8 to 17. The black region on one specimen includes most of the metasternum and parts of the pronotum and propodeum.

Eye 1.0 to 1.1 as wide as cheek; tyloids well marked, broadly oval.

The type of *propitius* is a male from Bosque County, Texas, now in the United States National Museum. *H. propitius* has been synonymized with *Ichneumon tharotis* Packard by Townes on the basis of a specimen not designated as the type but considered by him to be so. It is labeled "From Dr. Packard, M. tharos 3, Through C. V. Riley, Figure 4 Emerton" and is now in the National Museum type collection.

Material: 12 females and 12 males. Two males and one female, Lynnfield, Massachusetts, VI–24–1931 (US); female, Deering, New Hampshire, VII–11–1923 (US); female, Hampton, New Hampshire, VIII–5–1917, S. Albert Shaw (US); female, Ithaca, New York, VI–25–1890 (US); male, Ithaca, New York, VII–12–1938, "light"

(Tow); female, Long Beach, Long Island, New York, VIII–2–1925, "washup," F. M. Schott (US); female, Champaign Co., Illinois, M. W. Shackleford (US); male, Bowie, Maryland, XI–17–1945, H. H. Swift (Sw); female, Takoma Park, Maryland, VII–29–1943, H. and M. Townes (Tow); 2 males, Takoma Park, Maryland, X–17–1945, H. and M. Townes (Tow); 2 males, Takoma Park, Maryland, X–20–1945, H. and M. Townes (Tow); female, Takoma Park, Maryland, X–21–1945, H. H. Swift (Sw); female, Takoma Park, Maryland, X–21–1945, H. and M. Townes (Tow); female, Takoma Park, Maryland, XI–3–1945, H. H. Swift (Sw); 3 males, Takoma Park, Maryland, XI–3–1945, H. and M. Townes (Tow); female, Takoma Park, Maryland, XI–19–1943, H. K. Townes (Sw); male, Great Falls, Virginia, H. and M. Townes (Tow); male, type, Bosque Co., Texas, Belfrage (US); female, Waskesiu, Saskatchewan, VI–15–1938, J. G. Rempel (Tow).

The three specimens from Lynnfield and one from Deering were reared from *Melitaea harrisii* Scud. (Harris' checker spot) in the Massachusetts gypsy moth laboratory, and have the host chrysalis on the pin. The type of *tharotis* was reared from *Phyciodes tharos* (Dru.) (the pearl crescent) by A. S. Packard. *Melitaea harrisii* is a rather uncommon nymphalid. *Physiodes tharos*, a closely related species, is very common in fields all over the United States except in the extreme south and west. Larvae of both species feed on *Aster* and related genera. A series of 8 males and 3 females of *propitius* was reared from *Anemeca ehrenbergii* (Hbn.) in Cuernavaca, Mexico, June, 1945, by N. L. H. Krauss. Six males and 2 females of this series are now in the United States National Museum.

This species is not uncommon in the fall in dry upland fields where asters are plentiful. It has been taken several times flying around small scrub pine trees (*Pinus virginiana* Mill.), a habitat in which *teres* and many other fall ichneumonids are found.

This and the following species are differentiated from other North American members of the genus by the flat, polished clypeus. *H. propitius* is separated from *teres* by the characters listed under that species. *Melanichneumon rubicundus* (Cr.) and *Pterocormus putus* (Cr.), also small, red amblytelines, might conceivably be confused with either *teres* or *propitius*. Legs of both these species are, however, short and stout; *rubicundus* has the very small gastrocoeli typical on *Melanichneumon*; *putus* females have short, blunt tipped antennae. Red species of *Aoplus*, such as *cestus* (Cr.) and *velox* (Cr.), are readily distinguished by the gastrocoeli, which are each about 0.4 the abdominal width, weakly impressed, the impressed portion not rugose; the abdominal tergites are usually mat throughout, and are weakly and finely punctate.

7. Hoplismenus teres n. sp.

Hoplismensus rutilis (*l*) Brimley, Insects of North Carolina, 1938, p. 405.
Hoplismenus rutilus Townes, Mem. Amer. Ent. Soc., 1944, 11: 321 (in part).

This species is very similar to *propitius* and agrees with the description given for that species except as follows:

Female.—(Figure 3). Length 8 to 13 mm. Clypeus slightly

convex, the margin broadly rounded; cheeks viewed from in front essentially straight in outline; mandibles with the outer face convex and narrowing at the apex, twisted so that the shorter tooth arises dorsad of the longer, the shorter tooth not as wide as the longer at base, the teeth unequal by a distance greater than the width of the longer at base.

Male.—(Figure 2). Length 8 to 12 mm. Clypeus and mandibles as in female; eye 1.2 to 1.6 as wide as cheek; tyloids linear, often indistinct.

The type and allotype are in the Townes Collection, Takoma Park, Maryland.

Material: 10 females and 18 males. Female *type*, male *allotype* and male *paratype*, Great Falls, Virginia, X–10–1945, H. and M. Townes (Tow). *Paratypes*, male, Charlottesville, Virginia, X–19–1941, H. K. Townes (Tow); male, Charlottesville, Virginia, X–25–1941, H. K. Townes (Tow); female, Stubblefield Falls, Virginia, X–30–1921, "on Pinus virginiana," W. L. McAtee (Sw); male, Vienna, Virginia, XII–13–1913, R. A. Cushman (US); female, Patuxent Refuge, Bowie, Maryland, IX–6–1945, R. T. Mitchell (Mitchell Collection); female, Patuxent Refuge, Bowie, Maryland, X–2–1945, R. T. Mitchell (Mitchell Collection); male, Takoma Park, Maryland, IX–29–1945, H. and M. Townes (Tow); 3 females, Takoma Park, Maryland, X–7–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, X–13–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, X–17–1945, H. and M. Townes (Tow); male and female, Takoma Park, Maryland, X–21–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, XI–3–1945, H. H. Swift (Sw); female, Takoma Park, Maryland, XI–3–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, XI–7–1945, H. and M. Townes (Tow); male, Takoma Park, Maryland, XI–7–1945, H. H. Swift (Sw); male, Takoma Park, Maryland, XI–19–1943, H. K. Townes (Sw); female, Hocking Co., Ohio, X–8–1942, R. W. Strandtmann (Tow); male, Raleigh, North Carolina, VI–2–1937, C. S. B. (US); male, Tifton, Georgia, "9–2" 1896 (US); male, Opelousas, Louisiana, IV–6–1897, G. R. Pilate (US); male, Opelousas, Louisiana, V–6–1897, G. R. Pilate (US); male, Paradise Key, Florida, VI–7, D. M. DeLong (US).

A male of *teres* was reared by the author from a chrysalis of *Precis coenia* (Hbn.) (the buckeye) at Takoma Park, Maryland, November 7, 1945. Larvae of this butterfly feed on several species of plantain, particularly *Plantago lanceolata* L. In the vicinity of Washington, D. C., *teres* is fairly common in late fall. It occurs, as does *propitius*, around small scrub pines (*Pinus virginiana* Mill.) in abandoned fields, but seems to prefer somewhat damper localities where the food plants of the host are more abundant.

The male of *teres* has previously been considered as *rutilus* by Townes and Cushman. With the discovery of several females very like the males in structure identity of this form as a distinct species becomes obvious.

TAXONOMIC AND BIONOMIC NOTES ON SOME PANAMANIAN CHIGGERS[1]

(Acarina, Trombiculinae)

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In a previous paper the author has given an account of the life history of *Eutrombicula batatas* (Linnaeus). The number and general structure of the stages of the species discussed herein are, so far as known the same of those of *E. batatas*.

Eutrombicula helleri (Oudemans)

Microtrombidium helleri Oudemans, 1911, Ent. Ber., 30: 120; Oudemans, 1912, Zool. Jahrb., Suppl. 14 (1): 15; Oudemans, 1927, Tijdschr. v. Ent., 70: 72.
Trombicula helleri, van Thiel, 1930, Parasitology, 22: 351; Ewing, 1931, Proc. U. S. Nat. Mus., 80 (8): 8.
Eutrombicula helleri Ewing, 1938, Jour. Wash. Acad. Sci., 28: 294; Radford, 1942, Parasitology, 34: 66.

This species was originally described from a larva collected on a beetle in Dutch Guiana. There is little doubt that insects are not normal hosts for this species. Oudemans later (1927) recorded specimens from the same area on man, but van Thiel casts doubt on this host record, reporting that a rodent louse was present in the same lot with the mites. Since nothing more is known of this species, its discovery in Panama is of interest. Panamanian larvae agree well with Oudemans' description and figures except that he describes a plumose seta arising from the pedipalpal tibia. This seta is present but actually arises from the tarsus or thumb. The long simple third pedipalpal seta, directed posteriorly, is particularly characteristic.

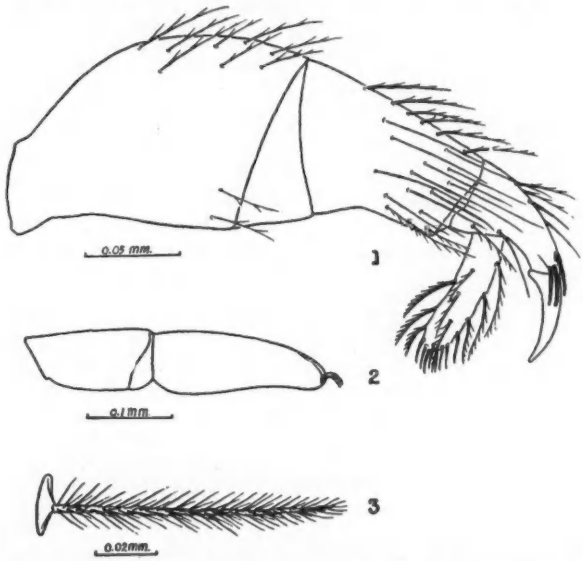
Collecting data for larvae of this species are given below:

Panama Province: Near Panama City; Point Viqué. Colon Province: Santa Rosa; Gatuncillo. Herrera Province: Parita. Canal Zone: Juan Mina; Barro Colorado Island. Dates of collection: January, February, March, July, October. Hosts: Lizard, *Ameiva praesignis* (5); Verreaux's dove, *Leptotila verreauxi* (1); a small flycatcher, *Tyrannidae* (1); domestic chicken, *Gallus gallus* (1); opossum, *Didelphis marsupialis* (1); agouti, *Dasyprocta punctata* (2); rat (unidentified native species) (1); forest rabbit, *Sylvilagus gabbi* (1); ocelot, *Felis pardalis* (1); man (1). Several specimens were also found on shoes. The numbers in parentheses indicate the number of specimens of each host on which larvae were found. This species is usually found in jungle or brush covered areas, not in open grassy places where *E. batatas* is often abundant.

Adult (female): Red. Length 1.3 mm. Body behind constriction much swollen. *Pedipalps* robust, with relatively few hairs, although

[1]The cost of publishing this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

more than in *E. batatas* or *vanommerani* (fig. 1), most of the hairs on inner surface of patella simple; tibia with three (or four on one side) blunt spines arising from a small elevation on inner side of segment near base of claw; claw with a rounded swelling at base of concave margin, as in *E. batatas*; dorsal margin of claw (measured in a straight line) 0.61 times length of tibia; finger with seven or eight short simple setae at apex, other setae strongly plumose; apex of finger slightly exceeding apex of claw. *Crista* slender, measured together with pseudostigmatic area, 0.19 mm. long; crista expands posteriorly rather abruptly into broad pseudostigmatic area (0.047 mm. wide measured to lateral margins of pseudostigmata) which is truncate posteriorly. *Eyes* represented by



1. Pedipalp of adult *Eutrombicula helleri*. 2. Last two segments of foreleg of same. 3. Hair from posterior portion of body of same.

small convexities postero-lateral to pseudostigmatic area. *Genitalia* with neck of sacculi of female conspicuous. *Body hairs* slender, nearly twice as long at posterior part of body as on shoulders, plumose throughout, distal setulae slightly shorter than basal; longest body hairs 0.11mm. long. *Legs* much shorter than body, total length of foreleg about 0.9 mm. Last segment of foreleg thickest near base, 1.25 times as long as next to last segment and not thicker than that segment, 2.8 times as long as broad.

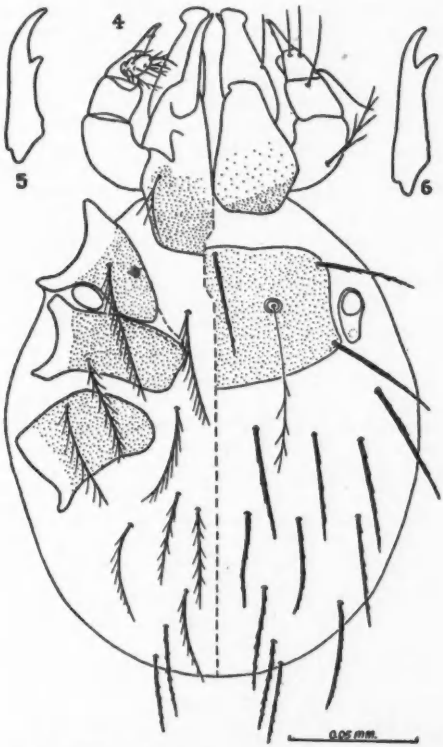
The single adult studied was found in leaf mold under trees at Santa Rosa, Colon Province, Panama, September 10, 1945 (C. D. Michener). It was placed in a jar of sterile earth and about two weeks later fifteen larvae, one of which is shown in figure 4, emerged.

This is the largest of the known adults of *Eutrombicula*.

Eutrombicula vanommereni (Schierbeek)

Trombicula vanommereni Schierbeek, 1937, Ann. Parasit. Hum. Comp., 15: 326; Schierbeek, 1938, Acta Leidensia, 12–13: 266; Radford, 1942, Parasitology, 34: 60.

This species was originally described from larvae from lizards collected in Dutch Guiana. A form which appears to be the same is common on lizards in Panama. Our specimens agree with the original



4. Larva of *Eutrombicula helleri* reared from adult illustrated in figures 1 to 3. 5. Pedipalpal claw of same. 6. Pedipalpal claw of larval *Eutrombicula vanommereni*.

description and differ from the accompanying figures chiefly in the less conspicuous posterior eyes. Except for the plumose third pedipalpal seta and the shape of the pedipalpal claw (fig. 6), *E. vanommereni* larvae agree with the figure of *E. helleri* (fig. 4).

This species is related to *E. alfreddugèsi* (Oudemans) from which the larva differs by having the second pedipalpal seta simple. It is also

close to *E. tropica* (Ewing). According to Dr. G. W. Wharton, who kindly examined the type of *E. tropica* for me, the second pedipalpal seta of that species is simple as in *E. vanommereni*, but the third is also simple, unlike the latter species. In this respect *E. tropica* is similar to *E. göldii* (Oudemans). Although these species are distinguished by only minute differences, the characters are constant in a large series of specimens from Panama. Apparently there are also differences between the adults of *E. alfreddugèsi*, *vanommereni* and *göldii*.

Collection data for larvae of *E. vanommereni* are given below:

Panama Province: Matías Hernández; Las Guacas. Colon Province: Santa Rosa; Agua Clara; three-fourths mile south of Río Limón; Gatuncillo. Darien Province: El Real. Canal Zone: Juan Mina. Dates of collection: December, January, February, March, June. Hosts: lizard, *Ameiva praesignis* (14); snake, *Drymarchon corais* (1); domestic chicken, *Gallus gallus* (1); Lafresnaye's sparrow, *Arremonops conirostris* (1); peccary, *Pecary angulatus* (1); white tailed deer, *Odocoileus chiriquensis* (1); domestic goat (1); spotted agouti, *Dasyprocta punctata* (1); capybara, *Hydrochoerus isthmius* (1); rat (unidentified native species) (2); forest rabbit, *Sylvilagus gabbi* (1). Specimens were taken on boots on many occasions.

The numbers in parentheses indicate the number of specimens of each host on which larvae were found. This species is often found in open grassy places in company with *E. batatas*. It also occurs in bushy areas.

On lizards (*Ameiva praesignis*) larvae sometimes remain attached for over three weeks before dropping, and do not detach on the death of the host. On the other hand, larvae on a snake (*Drymarchon corais*) detached soon after the death of the host.

Protonymph: Apparently not distinguishable from that of *E. batatas*.

Nymph: Pale red. Length about 0.5 mm. Similar to adult except for usual nymphal characters. Finger of pedipalp not parallel sided but slightly thickened basad of middle, bearing four or five short simple setae at apex. Longest hairs of shoulders about half as long as those of posterior end of body. Last segment of foreleg 1.39 to 1.53 times as long as next to last segment, 1.7 to 2.2 times as long as broad.

Preadult: Unknown.

Adult: Red. Length 0.9 to 1.1 mm. Body shape about as in *E. batatas*, that portion of body behind constriction not unusually swollen. *Pedipalp* with few hairs, as in *E. batatas*, most of those of inner margin of patella simple; inner surface of tibia with the usual three blunt spines arising from subapical protuberances and a single sharply pointed spine arising at about middle of upper margin; claw with rather sharp swelling at base of concave margin, as in *E. batatas*, dorsal margin of claw (measured in straight line, not around curve of claw) 0.61 to 0.62 times length of tibia; finger with seven or eight short simple setae at apex, other setae strongly plumose; finger shaped as in *E. helleri*, slightly exceeding claw. *Crista* slender, measured together with pseudostigmatic area 0.15 to 0.17 mm. long; crista expands posteriorly rather abruptly into broad pseudostigmatic area (0.059 to 0.075 mm. wide measured to lateral margins of pseudostigmata) which is truncate

posteriorly in some views, bilobated, the lobes separated by width of a lobe, in others; pseudostigmatic area with a transverse arcuate ridge anterior to pseudostigmata, as figured for *E. batatas*. Pseudostigmatic organs about as long as crista, with a few branches as in *E. batatas*. *Eyes* less conspicuous than in *E. batatas*, larger than in *E. helleri*, about half as wide as width of pseudostigmatic area. *Genitalia* with necks of sacculi of female conspicuous. *Body hairs* shaped about as figured for *E. batatas*, with long setulae throughout their lengths, longest hairs of shoulders about two-thirds as long as those of posterior end of body; longest body hairs 0.045 to 0.047 mm. long. *Legs* shorter than body, total length of foreleg about 0.73 mm.; forelegs longer and thicker than other legs, last segment thickest near base, not so slender apically as figured for *E. helleri*, 1.36 to 1.41 times as long as next to last segment and not thicker than that segment, 2.1 to 2.6 times as long as broad.

Nymphs and adults have not been collected in the field but have been reared from larvae on lizards (*Ameiva praesignis*), using the methods described elsewhere for *E. batatas*. The duration of the free living stages is apparently not greatly different from that of *E. batatas*, as shown by the following: larvae dropped from host November 22, nymphs observed December 2 and adults December 24.

Eutrombicula batatas (Linnaeus)

This species was the subject of a previous paper (Michener, 1946, Ann. Ent. Soc. Amer., 39: 101–118). The following synonymy completes that given there:

Trombidium batatas Oudemans, 1937, Kritisch Hist. Overzicht der Acarologie, Band D, p. 1384.

Eutrombicula batatas Michener, 1946, Ann. Rep. Gorgas Mem. Lab., 1945: 23; Michener, 1946, Ann. Ent. Soc. Amer., 39: 101; Michener, 1946, Amer. Jour. Trop. Med., 26: 251.

Acariscus flui and *hominis* Ewing, 1946, Proc. Biol. Soc. Wash., 59: 22.

With regard to the discussion of the plumosity of the third palpal seta of the larva, it should be noted that Schierbeek (1937, Ann. Parasit. Hum. Comp., 15: 326) states on the authority of van Thiel that this seta is plumose and was overlooked in the original description of *Trombicula flui* van Thiel. Islas (1943, An. Inst. Biol. Univ. Nac. Mexico, 14: 441) shows this seta as plumose in his figure of a Mexican specimen.

This mite has been collected at or near Santa Rosa, Colon Province, Panama, on several additional hosts[2] since the writing of the previous paper dealing with this species. These hosts are listed as follows: Cayenne wood rail, *Aramides cajanea* (1); little blue heron, *Florida caerulea* (5); Panama house wren, *Troglodytes musculus* (1); short-legged wood pewee, *Myiochanes cinereus* (1); Berlepsch's kingbird, *Tryannus melancholicus* (1); forest rabbit, *Sylvilagus gabbi* (1); domestic cattle (2). The numbers in parentheses indicate the number of specimens of each host on which larvae were found. Most of these hosts appear to be of

[2]Dr. Jorge Boshell Manrique writes that the "gallineta," mentioned as a host (of *pastorae*) by Boshell and Kerr, is the guinea hen (*Numida meleagris*), also recorded as a host by Ewing.

minor importance, only a few mites having been found on each. However, the little blue heron is important, some of the individuals examined having had nearly one thousand chiggers on them. This may be of importance in connection with an understanding of the survival of the species during the dry season. On the Pacific side of Panama *E. batatas* disappears during the dry season from most grassy areas around houses, where its main host is the domestic chicken. It was thought that

TABLE I

CHARACTERS OF ADULTS OF PANAMANIAN EUTROMBICULAS

(All measurements are in microns except as otherwise indicated.)

	batatas	*vanommereni*	*helleri*
Length (mm.)	0.7–1.0	0.9–1.1	1.3
Body shape	normal		swollen posteriorly
Length of pedipalpal claw	32–38	38–42	46
Dorsal margin of pedipalpal claw / Length of pedipalpal tibia	0.60–0.66	0.61–0.62	0.61
Number of short simple setae at apex of palpal finger	3–4	7–8	7–8
Length of crista and pseudostigmatic area	120–150	150–170	190
Breadth of pseudostigmatic area	47–57	59–75	47
Diameter of eye / Width of pseudostigmatic area	0.75–1.0	0.5	0.4
Length of longest shoulder hairs / Length of hairs at posterior end of body	0.7–0.8	0.6–0.7	0.5
Length of last segment of foreleg / Length of next to last segment of foreleg	1.41–1.49	1.36–1.41	1.25
Length of longest hairs of posterior end of body	36–40	45–47	110

perhaps the species survived in deep cracks in the soil, but this was not substantiated by digging. It now seems probable that it passes the dry season in damp grassy areas along streams frequented by herons and other birds, and is reestablished each wet season in the higher areas away from streams by movements of infested birds.

The number of eggs laid by individuals of this species is unknown. However, twenty-six larvae appeared in eighteen days in a jar of sterilized soil in which a single female of *E. batatas* was kept.

In connection with rearing methods, it should be noted that a far better method of feeding nymphs and adults than that used by me has been devised by Lt. Dale Jenkins. Following G. W. Wharton, he used insect eggs as food, and it seems probable that this is the normal food for nymphal and adult chiggers. However, a small number of individuals were reared by me in the absence of insect eggs when chicken manure was present in the rearing jars.

The characters useful for distinguishing the adults of the three Panamanian species of *Eutrombicula* known in that stage are indicated in Table I. Certain other characters which have been useful for other trombiculines are included in this table, even though of little value for the separation of the Panamanian species.

Trombicula panamensis Ewing

Trombicula panamensis Ewing, 1925, Amer. Jour. Trop. Med., 5: 259; Ewing, 1931, Proc. U. S. Nat. Mus., 8(8): 9.
Eutrombicula panamensis Ewing, 1938, Jour. Wash. Acad. Sci., 28: 294; Radford, 1942, Parasit., 34: 66.
Acariscus panamensis Ewing, 1943, Proc. Ent. Soc. Wash., 45: 59.

Larvae were found on two rats (unidentified native species) from Gatuncillo, Colon Province, Panama, collected by H. Trapido on March 5, 1945.

Most of the specimens have two subequal accessory prongs on the pedipalpal claws so that the species falls in *Trombicula*, not *Eutrombicula*. Ewing indicated that proper generic assignment was doubtful when he included the species in *Acariscus*.

Apparently there is complete intergradation, through various stages in the reduction of one of the accessory prongs of the claw, between typical *Trombicula* with three prongs in the palpal claws and the group of *Eutrombicula* in which there is a single outer prong shorter than the principal one. It is therefore believed that this group of *Eutrombicula* (including such species as *bruyanti* (Oudemans) and *panamensis* Ewing) should be transferred to *Trombicula*. The typical Eutrombiculas lack outer prongs on the pedipalpal claws but have a subapical or median tooth on the inner side.

ACKNOWLEDGMENTS

The author is indebted to the Gorgas Memorial Laboratory, Panama City, R. P., and particularly to its Director, Dr. Herbert C. Clark, for excellent facilities provided for this work. Roy Melvin and H. L. Dunn collected some of the larvae used in this study.

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THREE NEW MUSCOID FLIES FROM GUAM[1]

GEORGE E. BOHART[2] AND J. LINSLEY GRESSITT[3]

The following three species were collected in the course of biological studies of filth-inhabiting flies conducted at U. S. Naval Medical Research Unit No. 2, on Guam.

The holotypes and allotypes are deposited in the U. S. National Museum and the paratypes are in the California Academy of Sciences, the collection of the Hawaiian Sugar Planters Association Experiment Station, and the U. S. National Museum.

Subfamily **Phaoniinae**

Genus **Dichaetomyia** Malloch

Dichaetomyia Mall., 1921, Ann. Mag. Nat. Hist. (9) **7**: 163 (type: *D. polita* Mall.).

This genus is a large one, distributed over most of the Ethiopian, Oriental and southern Australasian regions. The following two new species are apparently the first ones to be recorded from an oceanic Pacific island north of Fiji and Samoa. Many species of this genus which were originally described in the genus *Mydaea* have not yet been associated with *Dichaetomyia*.

Dichaetomyia saperoi, n. sp.

Figure 1

Holotype, male.—Length 5.7 mm.; breadth at humeri 2 mm.; length of wing 5.5 mm.; testaceous, reddish orange on upper side of thorax, pitchy black on central two-thirds of abdomen, tarsi and mid- and hind tibiae pitchy brown.

Head about one-tenth wider than deep; narrowest width of frons less than diameter of ocellus; frons, parafacials, genae, and occiput black with silver pruinosity, antennal groove reddish, apex of clypeus pale testaceous; hairs and bristles of head (except on arista and labellum) black; frontals 5, the uppermost common to both sides; antenna testaceous, second segment orange, third slightly darkened apically, second segment with distal bristle one-third longer than proximal, arista darkening to black distally, 14 pinnae above and 12 below; palpus pitchy brown, about as long as third antennal segment, hardly twice as wide at widest point as at narrowest; haustellum with basal two-thirds pale testaceous. *Thorax* rich golden testaceous, prescutum and scutum orange with feeble whitish pruinosity when viewed from behind; 2 presutural and 4 postsutural dorsocentrals; posterior dorsocentrals and acrosticals forming a nearly straight line of equidistant bristles; humerals

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[1]The opinions expressed in this paper are those of the authors and do not necessarily represent those of the Navy Department.

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2, subequal; prostigmatics 2, lower weak; meso-, ptero- and sternopleura with numerous black hairs about one-half as long as anterior sternopleural bristle; anterior and posterior intra-alars much weaker than middle one, the latter displaced laterad about 4 bristle-socket diameters; middle supra-alar more than twice as long as anterior one; metathoracic spiracle with about 10 black setae along lower margin; squamopleuron with 2 or 3 black hairs at extreme upper corner and lateral postscutellum with about 12 scattered small ones. *Wing* with membrane slightly yellowish especially on basal fourth and anterior to second vein; veins

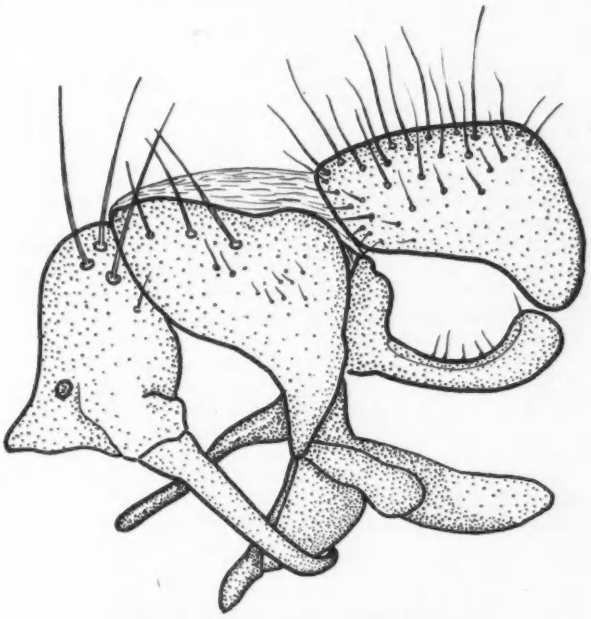

FIG. 1. *Dichaetomyia saperoi* G. Bohart and Gressitt, news pecies, genitalia of male paratopotype, left side.

fuscous; marginal crossvein slightly curved outwardly at anterior third and more strongly curved inwardly at posterior third; third and fourth longitudinal veins about equally curved upwards near apices; squamae slightly grayish, superior one with blackish rim and fringe hairs. *Haltere* testaceous. *Legs* with coxae and femora testaceous; fore tibia yellowish; mid- and hind tibiae and all tarsi pitchy black; fore femur with 9 long posteroventrals, 11 dorsals, the basal 3 weak, 11 posterodorsals, the distal 2 weak; midfemur with 6 widely spaced weak bristles on posteroventral margin, a transverse row of 3 preapical

bristles posterodorsally, and one short preapical anterodorsal bristle; hind femur with 15 bristles along anterodorsal margin; 3 preapical ones posterodorsally, 3 strong ones along apical third of anteroventral margin, and 4 strong ones along middle portion of anteroventral margin; fore tibia without bristles except at apex; midtibia divided into thirds by 2 stout bristles on posterior margin, encircled at apex by 5 apical and preapical bristles; hind tibia with one median anterodorsal and one median anteroventral bristle. *Abdomen* with first 2 segments, central, dorsal and ventral portions of third tergite, central portion of fifth tergite, genital segments and all sternites testaceous; central portion of fourth tergite dark reddish brown; remainder of abdomen pitchy black; laterally and dorsally fourth and fifth tergites with bristles in transverse rows as follows: apex of fourth 9 (subequally spaced), middle of fifth 6, apex of fifth 6; second sternite with a median pair of subapical, and a lateral pair of apical, bristles; third and fourth sternites each with 2 pairs of lateral bristles on apical third.

Allotype, female.—Length 5.8 mm.; breadth at humeri 2 mm.; length of wing 5.5 mm. Breadth of frons at level of posterior ocelli three-fourteenths of head breadth, at level of frontal lunule, one-third of head breadth; frontal stripe sooty black except for a slightly shiny ill-defined extension of ocellar triangle; frontals 5, upper 2 closely spaced; squamae yellowish with pale rims and fringes; midtibia with 3 bristles along posterior margin, 2 near middle, one midway between middle and apex; fourth abdominal tergite entirely black.

Paratypes.—Length 5.3–6 mm. Third abdominal tergite varying from dark reddish brown to black medially; frontal bristles varying from 5 to 6, the next to lowest sometimes minute; dorsal bristles on midtibia varying from 2 to 3 in both sexes; laterally and dorsally fourth and fifth tergites with bristles in transverse rows varying as follows: apex of fourth 9–11, middle of fifth 6, with a lateral ventral bristle sometimes appearing near lateral line, apex of fifth 6, the lateral pair sometimes appearing to be lateroventral.

Genitalia of male paratype illustrated in figure 1.

Holotype, male (No. 57916, U. S. National Museum), Pt. Ritidian, Guam, alt. 550 ft., on vegetation in dense forest, June 28, 1945, G. E. Bohart and J. L. Gressitt; *allotopotype*, female (U. S. N. M.), June 19, 1945, G. R. Norris; five *paratopotypes*, two males, three females, June 2 to August 2, G. Bohart and Gressitt; one *paratype*, male, Pt. Oca, Guam, June, 1945, taken in light trap, G. Bohart and Gressitt; six *paratypes*, all females, Pt. Ritidian, Guam, on human feces, J. L. Gressitt; three *paratypes*, females, were taken at Dededo, Guam, September 22, 1944, by D. G. Hall.

This species belongs to the *rufa* group, and differs from *D. rufa* (Stein) in having the mesopleuron with strong black hairs dorsally, from *D. megopthalma* Mall. in having the abdomen largely dark instead of completely pale, from *D. decipiens* (Stein), new combination, in having the pubescence of the occiput and underpart of face entirely black, and the tip of the abdomen yellowish instead of pitchy, from *D. flavohirta* Mall. in the completely black fourth abdominal segment and black meso- and sternopleural hairs, from *D. terraereginae* Mall. in having a row of long bristles on the posteroventral margin near the middle of the

hind femur, instead of a short row of very strong bristles on the apical fourth preceded by minute hairs, and from *D. impar* (Stein), new combination, in having the palpi, tibiae and tarsi dark.

This species is named in honor of Captain J. J. Sapero, MC, USNR, in recognition of his role in fostering entomological work in the Navy.

Dichaetomyia nigroscuta, n. sp.

Holotype, female.—Length 6.6 mm.; breadth at humeri 2.2 mm.; length of wing 6.2 mm.; reddish orange, the head and thorax, except antennae, humeral area, and scutellum, largely black.

Head with breadth to depth 6 : 7.5; breadth of frons at level of posterior ocelli four-fifths of head breadth, at level of frontal lunule, one-third of head breadth; frontal stripe slightly expanded at middle, where it is nearly two-thirds as broad as its median length; frons, parafacials, genae, occiput and antennal grooves black with silvery pruinosity, except for frontal stripe which is velvety black; clypeus nearly white; hairs and bristles of head (except on arista and labellum) black; frontals 6, second and fourth from bottom weak, lower 2 more widely spaced; antenna testaceous, second segment with subapical bristle three times as long as others; arista testaceous in basal third, otherwise black, dorsally with 13 pinnae and ventrally with 7; palpus velvety black, about as long as third antennal segment, over twice as wide at widest point as at narrowest; haustellum pitchy black. *Thorax* black with feeble pale pruinosity; humeri, sides of anterior declivity of prescutum, scutellum and posterolateral corners of scutum testaceous; sides of prescutum and scutum pitchy brown; sides and venter of thorax pitchy black, becoming brownish posteriorly; dorsum with a pair of extremely feeble vittae on prescutum between dorsocentrals; 2 presutural and 3 postsutural dorsocentrals; posterior dorsocentrals and acrosticals forming a nearly straight line of equidistant bristles; humerals 2, inner one two-thirds as long as outer; prostigmatics 3, middle one one-third longer than others; meso-, sterno- and pteropleura with a few black hairs less than one-fourth as long as sternopleural bristles; intra-alars 3, middle one displaced laterad 3 bristle-socket diameters, one-fourth longer than others; supra-alars 3, nearly in a straight line, middle one over twice as long as others; metathoracic spiracle with about 5 long black setae. *Wing* yellowish, especially anterior to second vein; veins testaceous basally, dark brown apically; marginal crossvein slightly curved outwardly at anterior third and more strongly curved inwardly at posterior third; squamae yellow. *Haltere* creamy yellow. *Legs* black; fore femur with 11 long posteroventrals, 7 anterodorsals and 9 dorsals; midfemur with a row of 3 bristles on basal half of ventral margin, middle one strongest, and 5 preapical bristles; hind femur with 14 anterodorsals, and 2 very strong bristles on apical third of anteroventral margin; ventral margin with a single strong bristle at basal fourth; fore tibia without bristles except at apex; midtibia roughly divided into thirds by 2 stout bristles on posterior margin; hind tibia with a median anterodorsal bristle and 2 anteroventrals, the proximal one opposite anterodorsal bristle. *Abdomen* reddish orange, sixth and seventh segments pale testaceous; laterally and dorsally fourth and

fifth tergites with bristles in transverse rows as follows: apex of fourth 12, middle of fifth 6, apex of fifth 6; second sternite with a transverse row of 4 subapical bristles; third and fourth sternites each with a pair of strong subapicals.

Paratype, female.—Length 7.2 mm.; frontal stripe three-fourths as broad as length at middle; abdominal bristles fewer in number than in holotype.

Holotype, female (No. 57917, U. S. National Museum), Mt. Santa Rosa, Guam, alt. 400 feet, *Pandanus* thicket, June 3, 1945, G. E. Bohart and J. L. Gressitt; *paratype*, female (Calif. Acad. Sci.), Mungmung, Guam, alt. 150 feet, taken in woods in trap baited with dead toads, July 10, 1945, G. Bohart and Gressitt.

This species is apparently not closely related to any previously described. It differs from *D. quadrata* (Wied.) in lacking the gray vittae of the mesonotum, in having the legs entirely black, the postsutural dorsocentrals three instead of four, and in many other characters.

Subfamily **Stomoxidinae**

Genus **Siphona** Meigen

Siphona Meig., 1803 (not 1824), Illiger's Mag. Ins. 2: 281 (type: *Stomoxys irritans* of Fabr. = *Stomoxys stimulans* Meig.).

This genus, as here considered, includes a group typified by *stimulans* which has a relatively short proboscis, long dilated palpus, and pinnae above and below on the arista. It corresponds to the genus *Haematobia* as used by Seguy.[1] Seguy's genus *Lyperosia* becomes *Haematobia* since the type of both is *Conops irritans* Linnaeus, and *Haematobia* is the older name.

Siphona carabao, n. sp.

Figure 2

Holotype, male.—Length 4.2 mm. (apex of abdomen recurved ventrally); breadth at humeri 1.8 mm.; greatest abdominal breadth 2.2 mm.; length of wing 4.3 mm. Body black to brown with dense gray-green to buff pruinosity; mesonotum with 2 pairs of dark brown sublateral stripes and a feeble interrupted median one.

Head almost one-fourth wider than deep; narrowest width of frons between eyes one-twelfth of greatest head-width; width of frons at vertex slightly over one-sixth of greatest head-width; in profile, parafacials practically flush with anterior margins of eyes, vibrissal angle projecting about as far forward as eye, with its longest bristle nearly three times as long as other vibrissae; frontal bristles in a single row of 14 on each side, mostly somewhat longer than narrowest width of frons; face, except for antennal grooves and frontal stripe, densely clothed with velvety golden pubescence; frontal stripe uniformly dark brown, narrower at middle than diameter of an ocellus; antenna dark brown, first segment with a row of inconspicuous bristles less than one-third as long as longest bristle of second segment; third segment oblong, twice

[1]Seguy, 1937, Gen. Ins. 205: 434.

as long as broad; arista with 10 dorsal pinnae of subequal length, the distalmost extending slightly beyond aristal apex, and 5 ventral bristles, the basalmost one-half as long as distelmost, and the latter inserted slightly basad to antepenultimate above; palpus testaceous except at tip, nearly three-fifths as long as head width, apical half expanded to fully twice narrowest part, apex with bristles much longer and stronger than elsewhere; haustellum dark reddish brown, pitchy apically, one-sixth longer than palpus. *Thorax* with pale gray pruinosity, having a distinct greenish cast especially close to lateral stripes of notum; viewed from above with light from behind, inner lateral stripe complete from anterior thoracic margin to middle of scutum, and outer stripe con-

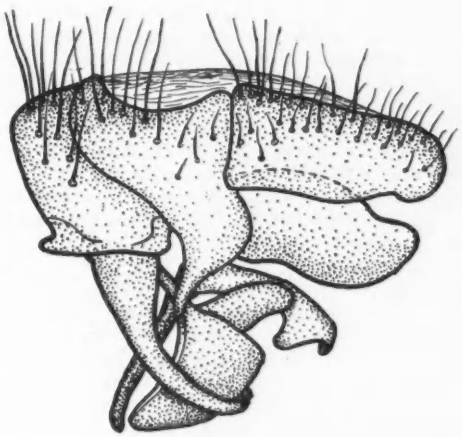

FIG. 2. *Siphona carabao* G. Bohart and Gressitt, new species, genitalia of male paratopotype, left side.

sisting of an oblique mark ending before scutum and continued as a free longitudinal stripe more closely approaching anterior, than posterior, border; median line of scutum with a triangular spot at anterior margin and a diffuse mark starting near center and broadening to posterior margin; vestiture black, suberect, mostly shorter than humeral cross-vein, about 10 hairs in a transverse row between inner notal stripes; supra-alars 1, post-alars 2; principal mesopleurals 13, fourth from top strongest, but only slightly longer than most of others; presutural much weaker than notopleurals; hairs on anterior portion of sternopleuron less than one-fifth as long as anterior sternopleural. *Wing* nearly colorless, slightly infuscated on basal quarter; first and third veins completely without distinctive hairs or bristles; squamae translucent dirty white; haltere creamy. *Legs* with femora gray, yellowish apically,

tibiae dull testaceous, tarsi nearly black; anterior surface of midfemur near the middle with a short oblique row of bristles somewhat longer than remainder; mid- and hind tibiae without strong bristles except at apices. *Abdomen* more buff in color than thorax and lacking green pruinosity; median line of first 3 tergites indistinctly brown; when viewed from behind, first 3 tergites each with a pair of broad oval brown areas occupying about one-half of their respective tergites; fourth tergite, viewed at a low angle from in front, with basal half brownish.

Allotype, female.—Length 4.0 mm. (abdomen recurved); breadth at humeri 1.6 mm. Frons near narrowest point two-fifths as broad as head, slightly broader at antennal insertions; frontal stripe slightly expanded at middle, with median length scarcely greater than width; face pale golden, silvery beneath, rich golden near vertex; dark markings of thorax less distinct than in holotype; femora yellowish.

Paratypes.—Length 4–5.5 mm.; 2 to 6 bristles on underside of arista; anterior sternopleurals sometimes weak; squamae sometimes yellowish apically and with distinctly yellowish rims.

Holotype, male (No. 57918, U. S. National Museum), Asan, south of Agāna, Guam, Mariana Islands, July 9, 1945, reared from fresh cattle dung, G. E. Bohart and J. L. Gressitt; *allotopotype*, female (U. S. N. M.), July 9; eleven *paratopotypes*, July, 1945; seven *paratypes*, southeastern coast of Guam, May 6, 1945, Pt. Manell, southern end of Guam, July 6, 1945, Ulomnia, southeastern Guam, May 10, 1945; all sucking blood from flanks of water buffalo or cattle, or reared from their feces. One male specimen taken at Saipan Island from a cow, July 1944, is apparently referable to the same species. Another male specimen from Ulomnia, Guam, appears to represent a color variant of this species. Its wings and squamae are distinctly yellow, the pruinosity of its body has a pronounced golden sheen, and its face is uniformly rich golden.

This species differs from *Siphona sanguisugens* (Austen), new combination, in lacking bristles on the third wing vein, and from *rufipes* Brunetti (which Suguy listed as the female of *sanguisugens*) in having one instead of two supra-alars and two instead of one post-alars. There are twice as many hairs in a row between inner stripes of scutum as in *Siphona perturbans* (Bezzi), new combination, and one-half as many as in *Siphona sanguinolenta* (Austen), new combination. The prescutal hairs in *carabao* are much shorter than those of *Siphona stimulans* (Meigen) and *sanguinolenta*, and somewhat longer than those of *perturbans*.

NEARCTIC STENUS OF THE CROCEATUS GROUP
(Coleoptera, Staphylinidae)

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The *croceatus* group of *Stenus* in the Nearctic region contains the species which belong to the subgenus *Hemistenus* Mots. They are characterized by having the abdomen strongly margined (paratergites present and horizontal) on tergites III to VI; tarsus short and broadened toward the apex, about 3–5 length of tibia and with third and fourth segments conspicuously bilobed (fig. 1); pronotum evenly rounded and without a longitudinal depression at middle. In addition to these features, the Nearctic species are generally 4 to 6 mm. in length. Body deep black, nearly evenly and finely punctured, and clothed with decumbent silvery pubescence. First antennal segment shining black, remainder reddish yellow and often dusky toward apex. Tarsi usually slightly to conspicuously lighter than femora and tibiae.

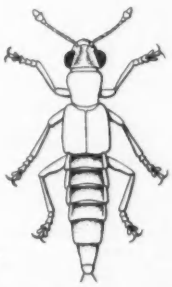


FIG. 1. *Stenus croceatus* Csy.

Although representatives of this group have been infrequent in collections submitted for study, their general distribution appears to be transcontinental chiefly through the northern United States and Canada. So far as known, the species are found in sphagnum bogs, wet mountain meadows and marsh habitats where they are at home walking or skimming about on the water surface.

The only paper treating the Nearctic species of this group is by Casey (1884) in which he keyed and described four species. Later (1892) he synonymized one of these, but evidence is presented here to show that it is valid.

The study of a greater series than has been previously assembled has shown that the most reliable characters for distinguishing the species are the male and female genitalia or associated abdominal segments.

These structures were treated with cold 5 to 10 per cent potassium hydroxide, and after washing were preserved in a small glycerine vial attached to the pin with the adult.

The terminology for the identity of the abdominal sclerites is essentially that of Blackwelder (1936). However, there is some evidence for considering that the apical flap of the ninth tergite of Blackwelder may be the tenth, and that the lateral plates of the ninth tergite join on the dorsum in *Stenus* to complete the dorsal part of the ninth segment. The ventral side of this segment is membranous; the following sternite is well developed and may be the tenth. In this case, the tenth sternite in *Stenus* would appear to follow the eighth. In addition to using these parts in this paper, an additional structure in the female genitalia is used to distinguish two species. This structure, which lies in the membrane on the inside of the genital capsule, is elongate, dorsoventrally flattened, and enlarged toward the apex of the abdomen. Possibly it may be the spermatheca although it is not circular in cross section similar to that observed in some females of other genera of Staphylinidae. It was not observed in females of *S. croceatus* and *S. fraternus*.

I am indebted to Dr. E. A. Chapin of the United States National Museum for comparing material with certain of the Casey types. I am also grateful to many institutions and individuals who have contributed material for these studies.

KEY TO SPECIES

1. Eighth sternite[1] emarginate at middle of posterior margin (males) 2
   Eighth sternite evenly rounded or angularly produced on posterior margin (females) 6
2. Apex of femur and base of tibia black, remainder of leg yellow; apex of median lobe of genitalia not reaching apices of lateral lobes, (fig. 18A), **croceatus**
   Tibia and femur uniformly black; apex of median lobe reaching or extending beyond apices of lateral lobes 3
3. Last sternite emarginate at apex, the lateral angles distinct (fig. 14); apex of median lobe reaching apices of lateral lobes; lateral lobes very broad and conspicuously rounded from base to apex (fig. 19A) ..... **fraternus**
   Last sternite truncate or slightly rounded at apex as in figs. 10, 11; apex of median lobe extended beyond apices of lateral lobes; lateral lobes slender and nearly straight, as in figs. 21A, 22 4
4. Basal piece of last sternite evenly narrowed toward apex of sternite (fig. 11); median lobe of genitalia evenly narrowed to blunt apex (fig. 21A) and with a recurved apical ventral hook (fig. 21B) ..... **umbratilis**
   Basal piece of last sternite subparallel along sides then narrowed toward apex of sternite (fig. 10); median lobe of genitalia slightly broadened and very thin at apex (figs. 20A and 20B) 5
5. Margin of aedeagal opening distinctly angulate as in fig. 20A ..... **retrusus**
   Margin of aedeagal opening nearly straight as in fig. 22 ..... **vista**
6. Apex of eighth sternite evenly rounded (fig. 9); apex of valvifer nearly evenly rounded and distinctly crenulate along apical margin (fig. 7), **croceatus**
   Apex of eighth sternite rather suddenly narrowed, the narrowed sides emarginate and produced into an angulate lobe (fig. 8); apex of valvifer slightly rounded or subtruncate but without conspicuous crenulations 7

[1]In counting segments, note that the first large cylindrical segment is morphologically the third.

7. Apex of valvifer acutely angled externally (fig. 5)..... **fraternus**
   Apex of valvifer nearly truncate, or rounded externally as in figs. 4 and 6.....8
8. Anterior margin of ninth tergite very deeply and angularly emarginate as in fig. 3..... **umbratilis**
   Anterior margin of ninth tergite with emargination evenly rounded and shallower as in fig. 2.....9
9. Spermatheca distinctly triangular with the base about one-half to two-thirds its total length (fig. 17)..... **retrusus**
   Spermatheca nearly truncate at base with base slightly less than one-third its total length (fig. 16)..... **vista**

Stenus croceatus Casey

Stenus croceatus Casey, 1884: 159.

The bicolored femur and tibia in both sexes will at once distinguish this species from all others in the group. In addition to some features of the male pointed out in the key, the structures of the aedeagus are more complicated than in the other species (fig. 18B). The last sternite of the male is emarginate and distinctly crenulate on the posterior margin and with postero-lateral angles distinct (fig. 12).

Known from District of Columbia, Illinois, Manitoba, Massachusetts, Michigan, New York, New Jersey, Nebraska, Ontario, and Quebec. In Illinois it has been taken abundantly in many marshes, especially in the northeast section of the state. They seem to prefer cattail marshes but have been found in grassy marshes and sphagnum bogs. This species often occurs among the cattails a hundred or more feet from land, and has the remarkable ability to skim gracefully on the surface of the water. This method of locomotion has been described for some British representatives of the genus (Joy, 1910) and is achieved by the secretion from repugnatorial glands at the end of the abdomen. The secretion from these glands lowers the surface tension of the water round the caudal end of the beetle, and the greater surface tension on which the front parts of the beetle rests pulls it rapidly forward.

Stenus fraternus Casey

Stenus fraternus Casey, 1884: 155.
Stenus fraternus Casey, 1892: 712.

Superficially resembles ***umbratilis*** Casey very closely. Casey (1892) synonymized ***fraternus*** with ***umbratilis*** without comment. Males of the two species show striking differences in the last sternite as well as in the genitalia. In this species the postero-lateral angles of this sternite in both sexes is acute. In ***umbratilis***, the angles are blunt and the entire end of the sternite is subtruncate.

Casey originally recorded the species from three specimens taken in Wyoming Territory, and Marquette, Michigan. Additional material has been examined from: ALBERTA—Edmonton, June to August, 1917 and 1918, F. S. Carr. COLORADO—Ten miles north of Rabbit Ear Pass, August 21, 1941, H. C. Severin. MANITOBA—Stonewall, May 25, 1919, J. B. Wallis. NORTHWEST TERRITORY—Tununuk, Mackenzie River, August 10, 1930, O. Bryant.

Stenus umbratilis Casey

Stenus umbratilis Casey, 1884: 156.
Stenus umbratilis Casey, 1892: 712.

The important characters distinguishing this species and ***fraternus*** are given in the key, and in notes under ***fraternus***. These two species form a complex within the ***croceatus*** group, having a distinct carina bordering the punctured area on the last sternite of the males. In other species of the ***croceatus*** group, the carina is completely absent. The ***umbratilis*** complex also differs by having the tarsi only slightly lighter than the tibiae, and the apex of the median lobe of the male genitalia is recurved.

Described from Lake Quesnel, British Columbia. Additional records are noted from: ALBERTA—Edmonton, June 25, 1917, F. S. Carr. MANITOBA—Churchill, July and August, 1937, W. J. Brown; H. B. R., mile 214, July 9, 1917, J. B. Wallis; Piquitenary, July 24 to July 26, 1917, J. B. Wallis. NORTHWEST TERRITORY—Aklavik, April 27, 1931, and August 13, 1932, O. Bryant. QUEBEC—Natashquan, August 10, 1929, W. J. Brown.

Stenus retrusus Casey

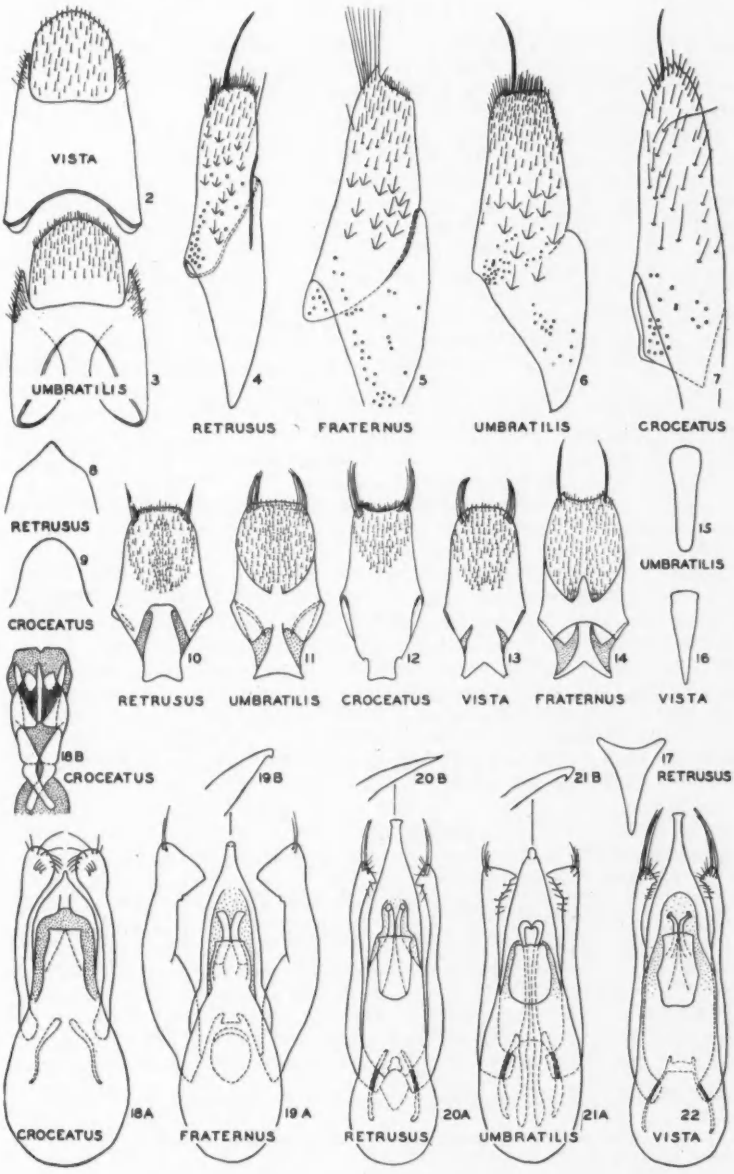
Stenus retrusus Casey, 1884: 154.

From the ***umbratilis*** complex, ***retrusus*** and ***vista*** are distinguished by having the tarsi distinctly lighter than the tibiae. These two species appear to be indistinguishable on the basis of external characters but are satisfactorily differentiated by characters of the male and female genitalia. The male genitalia of ***retrusus*** have the lateral margins of the opening near the double aedeagal processes distinctly angulate (fig. 20A), and the apical part of the median lobe is comparatively broader than in ***vista***. The valvifers of the female (fig. 4) show no significant differences, but the triangular structures lying in the membrane of the genital capsule are distinctive. In ***retrusus***, the structure is emarginate on three sides with the posterior margin not less than one-half the total length (fig. 17).

Originally described from one female taken on Vancouver Island, British Columbia. Additional specimens, including males, have been collected as follows: OREGON—Bly Mountains, June 13, 1945, K. M. Fender, mountain meadow; Clear Lake, Mt. Hood National Forest, June 15 and October 7, 1945, K. M. Fender, sweeping in meadow; Elk Lake, July 3, 1938, K. M. Fender; McMinnville, Peavine Ridge, October 15, 1945, K. M. Fender, sweeping reeds and sedges. WASHINGTON—King County, Evans Creek, May 11, 1929, M. H. Hatch; Pierre County, Silver Lake, May 12, 1934, M. H. Hatch; Seattle, April 13, 1932, M. H. Hatch.

EXPLANATION OF PLATE

FIGS. 2 and 3. *Stenus* spp. Ninth tergite of female. FIGS. 4 to 7. *Stenus* spp. Valvifer of female genitalia. FIGS. 8 and 9. *Stenus* spp. Apex of eighth sternite of female. FIGS. 10 to 14. *Stenus* spp. Last sternite of male. FIGS. 15 to 17. *Stenus* spp. Spermatheca. FIGS. 18A and 18B. *Stenus croceatus*. Male genitalia and aedeagus. FIGS. 19 to 22. *Stenus* spp. Male genitalia and lateral aspect of apex of median lobe.


VISTA
2
UMBRATILIS
3
4
5
6
7
RETRUSUS
FRATERNUS
UMBRATILIS
CROCEATUS
8
RETRUSUS
9
CROCEATUS
10
11
12
13
14
15
UMBRATILIS
16
RETRUSUS
UMBRATILIS
CROCEATUS
VISTA
FRATERNUS
VISTA
18B
CROCEATUS
19B
20B
21B
17
RETRUSUS
18A
CROCEATUS
19A
FRATERNUS
20A
RETRUSUS
21A
UMBRATILIS
22
VISTA

Stenus vista n. sp.

Male.—Length 3 to 4 mm. Body black and somewhat dull above except on the vertex where it is more shining. Antennae and palpi reddish yellow and dusky toward apex. Legs entirely black except the tarsi which are reddish yellow. Posterior margin of eighth sternite triangularly emarginate, the emargination extending for about one-third the length of sternite. Last sternite subtruncate and slightly uneven at apex with a group of several long hairs in posterior lateral region; base Y-shaped (fig. 13), the emargination triangular. Median lobe of genitalia extending beyond lateral lobes, very narrow toward apex and with tip suddenly flared (fig. 22); apical part, in side view, evenly tapered; margin of aedeagal opening straight or nearly so.

Female.—Similar in size and general appearance to male. Eighth sternite angulate on posterior margin as in fig. 8. Valvifer similar to that of *retrusus* (fig. 4). Spermatheca gradually enlarged toward apex of abdomen, sides straight then subparallel in apical one-third.

This species is closely related to *retrusus* Casey, and I have been unable to distinguish them except by the genitalia. As far as the material available for study indicates, the ranges of the two species do not overlap. *S. retrusus* appears to be confined to the Pacific coast region from Oregon to British Columbia.

Holotype, male.—Buena Vista, Colorado, August 4, 1943, H. H. and J. A. Ross, sweeping vegetation at margin of Yale Lake. In collection of Illinois Natural History Survey.

Allotype, female.—Same data as for holotype.

Paratypes.—COLORADO—Buena Vista, August 4, 1943, H. H. and J. A. Ross, 1♂, 1♀. Estes Park, August 27, 1920, H. C. Severin, altitude 8800 feet, 1♂ (South Dakota State College); Electra Lake, June 28 to July 1, 1919, altitude 8400 feet, 1♂ (American Museum). MANITOBA—Churchill, August 18, 1937, W. J. Brown, 3♀ (Canadian National Collection); August 2–9, 1937, D. G. Denning, 1♀ (M. H. Hatch); Churchill River, August 5–6, 1937, D. G. Denning, 1♀ (M. H. Hatch). NORTHWEST TERRITORY—Tununuk, Mackenzie River, August 10, 1930, O. Bryant, Lot. 114, 1♂, 1♀ (C. A. Frost).

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THE TAXONOMY AND BIONOMICS OF A NEW SUBGENUS OF CHIGGER MITES[1]

(Acarina, Trombiculinae)

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The classification of the trombiculine mites has been based primarily on the larval stages, since it is the larvae which are parasitic. The nymphs and adults are relatively difficult to collect and have been little studied. This is unfortunate, since, as more correlations between larvae and adults are made, it becomes apparent that at least in some groups the nymphs and adults offer the most conspicuous generic and specific characters. Considerable confusion in the generic classification will doubtless exist until nymphs or adults are known for all of the named larval genera. Nymphs or adults and larvae are now known for enough species, however, so that some preliminary conclusions concerning the classification can be reached.

APPLICATION OF THE NAME TROMBICULA

The generic name *Trombicula* Berlese (1905) is unfortunately based upon an adult of a Javan species, *T. minor*, not yet known in the larval stage. As shown by Willman (1941) and Ewing (1944) it is a minute species with relatively huge pseudostigmata, with peculiar parallel-sided pedipalpal claws, and with the subapical spines of the pedipalps setiform. It may eventually be shown that some generic name based on larvae is a synonym of *Trombicula* Berlese. In any event, however, the adults of the species whose larvae have usually been placed in the genus *Trombicula* are obviously generically distinct from *Trombicula* Berlese. For this reason *Trombicula* of authors[3] should eventually be called by another name. *Leptotrombidium* Nagayo, Miyakawa, Mitamura, and Imamura is available and might be used for this group. However, the name *Kedania* Kishida, if validly published, has priority over *Leptotrombidium*. Apparently no one in America has seen the paper in which this name was published. Until the validity of *Kedania* can be determined, it seems best to use the name *Trombicula* in its current sense, in order to avoid repeated generic changes.

The following are some of the species which evidently are to be transferred eventually from *Trombicula* to *Leptotrombidium* or *Kedania*: *akamushi* Brumpt, *alleei* Ewing, *ardeae* Trågardh, *autumnalis* Shaw, *blarinae* Ewing, *burmensis* Ewing, *californica* Ewing, *centropodis* Ewing, *cervulicola* Ewing, *cynictia* Radford, *cynos* Ewing, *dasyproctae* Ewing, *deliensis* Walch, *fahrenholzi* Oudemans, *fulleri* Ewing, *hamertoni* Radford, *intermedia* Nagayo, *mastomyia* Radford, *mexicana* Ewing, *microti*

[1]The cost of publishing this article is paid by the Gorgas Memorial Laboratory.—EDITOR.

[2]Now at the American Museum of Natural History, New York City.

[3]According to Ewing (1938) the name *Trombicula* was first applied to larval mites (*akamushi*) by Kitashima and Miyajima (1918).

Ewing, *muris* Oudemans, *nigeriensis* Ewing, *oregonensis* Ewing, *pallida* Nagayo, *palpalis* Nagayo, *parkeri* Radford, *peromysci* Ewing, *peruviana* Ewing, *piercei* Ewing, *praomyia* Radford, *punctata* Boshell and Kerr, *rohweri* Ewing, *scutellaris* Nagayo, *setosa* Ewing, *shannoni* Ewing, *trägardhi* Oudemans, *velascoi* Boshell and Kerr, *walchi* Womersley and Heaslip, *whartoni* Ewing.

TROMBICULA AND ITS ALLIES

The majority of the known species of chigger mite larvae belong to a group of genera in which the pseudostigmatic organs of the larvae are not clavate; there are fine setae on the dorsal plate, none of them peculiarly modified; the chelicerae each have a single dorsal tooth; and the pedipalpal claw is bifid or trifid. In the most recent generic classification (Ewing, 1944a) these genera are listed as *Trombicula*, *Eutrombicula*, and *Acariscus*. The last of these does not appear to differ by any suitable generic character in either larvae or adults from *Eutrombicula*, and has been sunk as a synonym of that genus (Michener, 1946).

Eutrombicula differs from *Trombicula* in having bifid rather than trifid pedipalpal claws in the larvae. It appears to me probable that *Eutrombicula* should be restricted to species having the two points of the claws equal, or the outer (dorsal) longer. Those species, commonly included in *Eutrombicula*, in which the outer prong is slender and shorter than the principal prong are merely species of *Trombicula* in which one of the two small outer prongs has disappeared. Every intergradation is found between three-pronged claws and two-pronged ones of this sort, but I have seen no intergradation between *Eutrombicula* as here restricted and *Trombicula*.

No differences have been observed between adults of *Eutrombicula* and *Trombicula* s. str.,[4] except that eyes are absent in the known adults of the latter group. Apparently they are either present or absent in *Eutrombicula*. There is a group, however, described below as a new subgenus of *Trombicula*, in which the adults are very different. The larvae of this group are indistinguishable from those of *Trombicula*, and it is for this reason only that the new group is not considered a separate genus.

Subgenus **Megatrombicula** nov.

A new subgeneric name, *Megatrombicula*, is proposed for a group of species of *Trombicula* so far known only from tropical America. The characters are indicated in Table I.

Type species: Trombicula alleei Ewing. The new subgenus includes also *T. velascoi* (Boshell and Kerr), *T. peruviana* (Ewing) and *T. attenuata*, new species. It is possible that certain other species, such as *Trombicula hamertoni* (Radford), now known only from larvae, belong to this subgenus.

Adults of the three species of *Megatrombicula* found in Panama also agree in the following features, which may also be found to distinguish

[4]Here as elsewhere in this paper the expression "*Trombicula* s. str." means *Trombicula* in its strict current sense, and refers in no way to the true *Trombicula* Berlese.

the subgenus from *Trombicula* s. str.: Legs and pedipalps with numerous setae; structure of the female genitalia labeled "neck of (?) sacculus" by Ewing (1944a) not visible; lateral margins of penal cone of male with three or four short setae; pseudostigmatic organs simple.

The larvae of *Megatrombicula* agree in the shape of the dorsal plate with those of *Pentagonella* Thor (1936, Zool. Anz., 114: 30), a generic name which has received little attention, possibly because it has been considered a synonym of *Trombicula*. *Pentagonella* was separated from *Trombicula* primarily by the more or less angulate posterior margin of the dorsal plate. Radford (1946, Parasitology, 37: 51) has described the nymph of *Trombicula acuscutellaris* Walch, one of the species included in *Pantagonella*. In this species the pedipalpal tibia is of the usual shape for *Trombicula* s. str. and the eyes, not being mentioned, are assumed to be absent or at least not in an unusual position. It therefore seems reasonable to consider the New World *Megatrombicula* as distinct from the Old World *Pentagonella*, which is probably best considered a synonym of *Trombicula*.

Curiously, for a group in which most species are known only as larvae, all described species of *Megatrombicula* have previously been known only as adults. Perhaps this is because larvae of this subgenus become so much engorged on their hosts that they often make unsatisfactory specimens, and students of this group have hesitated to describe them. Since the larvae of this group are exceedingly similar they are treated separately at the end of this paper.

TABLE I

Megatrombicula, new subgenus	*Trombicula*, s. str.
Adult: Length over 1.5 mm.	*Adult:* Length under 1 mm.
Eyes large and convex, approximately midway between anterior and posterior ends of crista, far anterior to pseudostigmatic area.	Eyes absent (at least in *T. akamushi* and *T. autumnalis*.)
Tibia of pedipalp slender, over three times as long as broad.	Tibia of pedipalp short, robust, less than three times as long as broad.
Sternal plate (between anterior two pairs of coxae) more than twice as broad as long.	Sternal plate not or scarcely broader than long. (?)
Larva: Dorsal abdominal setae (counting marginal ones) twenty-four, arranged as follows: 2-6-6-6-2-2.	*Larva:* Dorsal abdominal setae usually more than thirty.
Deutovum: With several spines in addition to dorsal one.	*Deutovum:* With a single dorsal spine. (?)

KEY TO THE ADULTS OF MEGATROMBICULA

1. Tibia of pedipalp with comb of three spines on inner surface near claw, and usually one other spine.....2
   Tibia of pedipalp with eight to seventeen spines on inner surface....**velascoi**

2. Body hairs with apices almost bare of setulae.....**peruviana**
   Body hairs plumose throughout length, apices not bare of setulae.....3
3. Last segment of front leg parallel sided, more than four times as long as broad, scarcely broader than preceding segment; pedipalpal claw very small, less than one-third as long as finger.....**attenuata**
   Last segment of front leg of the usual shape, broadest medially, less than three times as long as broad, broader than preceding segment; pedipalpal claw more than one-third as long as finger.....**alleei**

KEY TO THE KNOWN NYMPHS OF MEGATROMBICULA

1. Tibia of pedipalp with one or two spines on inner surface near apex; hairs of posterior end of body 0.05 to 0.07 mm. long, less than twice as long as those of shoulders.....**alleei**
   Tibia of pedipalp with three to five spines on inner surface near apex; hairs of posterior end of body 0.09 to 0.14 mm. long, two to three times as long as those of shoulders.....**velascoi**

Trombicula (Megatrombicula) peruviana Ewing

Trombicula peruviana Ewing, 1926, Ent. News, 37: 112; Ewing, 1931, Proc. U. S. Nat. Mus., 80 (8): 9; Ewing, 1933, Proc. U. S. Nat. Mus., 82 (29): 2.

This species is known from a single adult specimen, now in the United States National Museum, from El Campaniento (probably El Campamento), Peru.

Trombicula (Megatrombicula) alleei Ewing

Trombicula alleei Ewing, 1926, Ent. News, 37: 111; Ewing, 1931, Proc. U. S. Nat. Mus., 80 (8): 6; Ewing, 1933, Proc. U. S. Nat. Mus., 82 (29): 2.

Adult: Length 1.5 to 2.5 mm. Brilliant red in life. Claw of *pedipalp* measured along upper margin 0.30 to 0.36 times length of pedipalpal tibiae; inner surface of tibia with three spines arising from a small projection, and a fourth arising from near upper margin of segment much nearer base; finger of pedipalp with four or five small bristles at apex, setae of finger mostly simple. *Crista* rodlike, expanded gradually to the rear into the triangular pseudostigmatic area, which bears the pseudostigmata at its posterior lateral angles; pseudostigmata simple, about as long as crista. *Body hairs* densely plumose throughout lengths, scarcely longer posteriorly than on shoulders, the longest hairs ranging from 0.07 to 0.16 mm. in length. *Legs* shorter than body or first pair about as long as body, robust; last tarsal segment of anterior leg swollen, broadest near middle, less than three times and sometimes only a little more than twice as long as broad, 1.30 to 1.38 times as long as preceding segment and broader than that segment.

Adults of this species have been collected at Juan Mina, Canal Zone, Panama. Larvae have been found at the same locality; at Gamboa, Canal Zone, Panama; at Santa Rosa, Colon Province, Panama; and at Las Guacas, Panama Province, Panama. The type locality is Barro Colorado Island, Canal Zone, Panama.

The holotype (a male according to a letter from Dr. E. W. Baker) is in the United States National Museum. Dr. G. W. Wharton has kindly compared my specimens with the type and regards them as the same species.

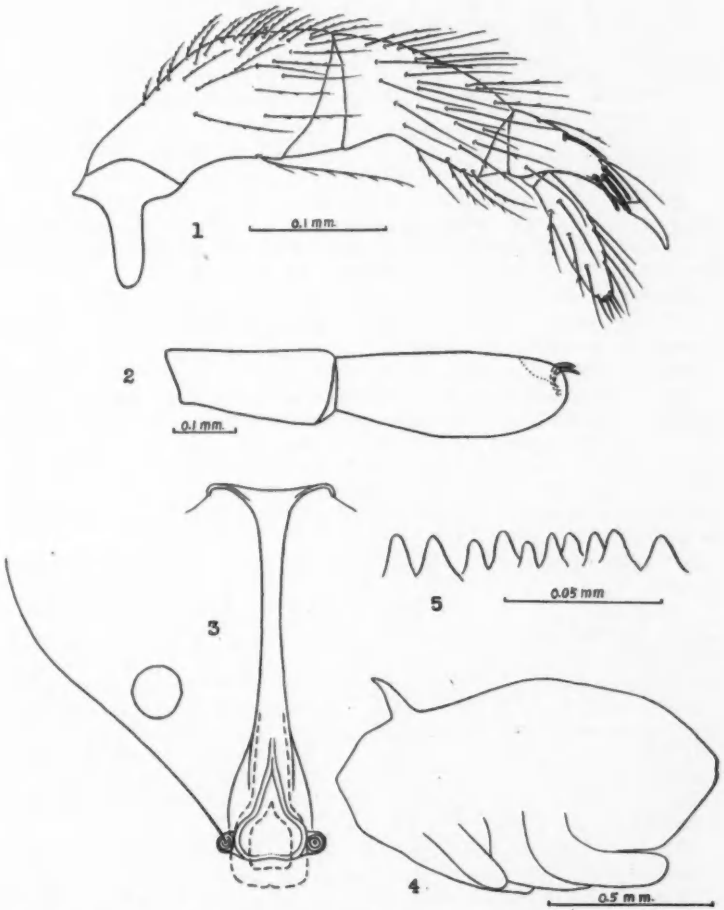


FIG. 1. Lateral view of pedipalp of adult *Trombicula alleei*. 2. Last two segments of foreleg of adult *T. alleei* (Figures 1 and 2 were drawn from small specimens collected on *Pistia* leaves). 3. Crista and associated structures of *T. alleei*. 4. Protonymph of *T. alleei*. 5. Detail of surface sculpture of living protonymph of *T. alleei*.

Great variation in size has been observed in adults of this species and it was at one time believed that the large and small specimens represented two separate species. However, intermediate specimens have been studied, and larvae of the large and small adults appear to be indistinguishable. Since small specimens have been found only on floating plants of *Pistia stratiotes* (a habitat more fully discussed under *T. attenuata*) it is assumed that this habitat is less suitable than the usual terrestrial one.

Egg: Diameter 0.17 to 0.19 mm. Orange, spherical, almost smooth but showing very faint reticulate pattern.

Deutovum: Dorsal median spine not unusually large; each side of body with four large tubercles, two of them tipped with sharp spines (fig. 23); leg sheaths and posterior portion of body smooth, but median portion minutely and rather sparsely tuberculate.

Larva: Described in a subsequent section of this paper.

Protonymph: Dorsal spine unusually long and slender, body surface coarsely tuberculate.

Nymph: Length (when freshly emerged) 1.0 to 1.2 mm. Similar to adult except for usual nymphal characteristics; claw of pedipalp nearly half as long as tibia, which is not so slender as in adult; inner surface of tibia with two, or sometimes only one subapical spine. Body hairs sparser than in adult, those of posterior end of body conspicuously longer than those of shoulders, longest ones 0.05 to 0.07 mm. in length. Legs similar to adult, last segment of foreleg 1.40 to 1.50 times as long as next to last.

Preadult: Similar to protonymph but dorsal spine (in the single specimen studied) not so long.

Bionomics: Adults of this species have been collected at all seasons of the year in wet leafmold close to the shore of the Chagres River at Juan Mina, under aquatic vegetation left stranded on the river banks by receding water, and on floating plants of *Pistia stratiotes* in the Rio Hondo, near Juan Mina. Specimens from the latter habitat were few in number and smaller than the others. It is probable that this is a relatively unsatisfactory habitat. A preadult was found in one of the grooves on the under side of a *Pistia* leaf. An adult was also collected under a rock along a very small stream some distance from the river.

The only eggs studied were laid singly or in twos, threes, or fours on leaves of *Pistia* by specimens collected on this plant. It is possible that larger specimens lay their eggs in masses since some thirty larvae emerged at the same time from wet leaf mold in a rearing jar in which an adult female of this species was kept.

The duration of the egg stage is eight or nine days, and of the deutoval stage about the same.

Larvae have been collected from September through March. They are active, slightly larger on hatching than those of the local species of *Eutrombicula* (i. e., body 0.22 to 0.25 mm. in length), and after engorgement often reach a length of 0.75 mm. It is because of this relatively immense engorgement that freshly emerged nymphs of this species are

larger than the largest adults of such species as ***Eutrombicula batatas*** (Linnaeus).

In contrast to ***batatas***, the larvae of ***T. alleei*** cause a conspicuous local effect on the host. On birds, which are the chief hosts of ***T. alleei***, a yellowish swelling forms a ring surrounding each attached larva or group of larvae. This swelling, which is rather hard, doubtless provides considerable protection for the large larvae.

The hosts on which larvae have been collected are listed below. The number following each species is the number of specimens of the host on which larvae of ***T. alleei*** have been found. Each asterisk (*) indicates a host specimen from which larvae were reared to nymphs and the identification checked by the nymphal characters. As would be expected from the adult habitat, several aquatic and shore birds are included in the list, and most of the terrestrial hosts were from near the shore of the Chagres River. For example, the chickens were feeding in the damp shore vegetation at Juan Mina.

Snake bird, ***Anhinga anhinga*** (1); little blue heron, ***Florida caerulea*** (2); American egret, ***Casmerodius albus*** (1); blue winged teal, ***Anas discors*** (1); ***Buteo***-like hawk (1); domestic chicken, ***Gallus gallus*** (4); purple gallinule, ***Porphyrula martinica*** (1); squirrel cuckoo, ***Piaya cayana*** (1); ani, ***Crotophaga ani*** (6); massena trogon, ***Trogon massena*** (1); black-crested ant shrike, ***Thamnophilus doliatus*** (1); Berlepsch's kingbird, ***Tyrannus melancholicus*** (1*); Cayenne flycatcher, ***Myiozetetes cayanensis*** (2); Colombian vermillion-crowned flycatcher, ***Myiozetetes similis*** (5***); Panama flycatcher, ***Myiarchus ferox*** (1); Pewee, ***Myiochanes*** sp.? (1); Galbraith's wren, ***Thryothorus leucotis*** (1); Prévost's Cacique, ***Amblycercus holosericeus*** (1); Panama black-headed saltator, ***Saltator atriceps*** (1); forest rabbit, ***Sylvilagus gabbi*** (2).

As indicated by the work of Lt. Dale W. Jenkins, larvae drop from chickens for up to seven days after the chickens are caged. Engorged larvae drop within a few hours if the host animal is killed. Placed in jars lined with plaster of Paris, as described (Michener, 1946a) in connection with the rearing of ***E. batatas***, they walk about for two or three days and finally become quiescent in a dark hiding place. The protonymph forms within another day or two, the distended larval skin breaking in many places to expose the integument of the protonymph. Larvae which dropped from killed wild birds required from fourteen to sixteen days (or in one instance twenty-one days) after leaving the host until the appearance of the nymph. However, larvae which dropped normally from live chickens required only seven to nine days to transform into nymphs.

In spite of the large size of these mites, adulthood is apparently reached with the same number of molts as in ***E. batatas***, there being no additional nymphal or adult stages. No specimen has been reared through the entire life cycle but individual specimens have been observed and appendages measured before and after each molt. The appendages of, for example, a freshly emerged nymph are the same size as those of a nymph about to transform into an adult. The growth which occurs during this as well as other stages involves no molting but merely stretching of the body integument.

Trombicula (Megatrombicula) velascoi Boshell and Kerr

Trombicula velascoi Boshell and Kerr, 1942, Rev. Acad. Colombiana Cien. Exact., Físic Nat., 5: 113.

Adult: Length 1.6 to 2.5 mm. Brilliant red in life. Claw of *pedipalp* measured along upper margin 0.30 to 0.36 times length of pedipalpal tibia; inner surface of tibia with eight to seventeen spines (average of twenty-five specimens 12.1) arranged around lateral and apical margins, those nearest apex consistently present, those nearer base of segment frequently absent, so that the row of spines is sometimes broken by large gaps; sometimes there are one or two spines arising near middle of segment, not in marginal row; finger of pedipalp with five to seven short simple bristles apically, other hairs mostly barbed or plumose. *Crista* and pseudo-stigmatic organs similar to those of *alleei*. *Body hairs* about two-thirds as long on shoulders as on posterior end of body, plumose but the setulae smaller toward apices of hairs and sometimes absent from extreme apices; longest body hairs 0.15 to 0.20 mm. in length. *Legs* shorter than body or first pair as long as body, robust; last tarsal segment of anterior legs somewhat swollen, broadest near middle, slightly less than three times to over four times as long as broad, 1.49 to 1.61 times as long as preceding segment and ordinarily broader than that segment.

This species has been collected at Juan Mina and Chiva Chiva, Canal Zone, Panama; Old Panama, Panama Province, Panama; and Santa Rosa, Colon Province, Panama.

The type locality is Restrepo, Intendencia de Meta, Colombia. It is also known from Villavicencio, Intendencia de Meta and the Municipio de Bolívar, Santander Province, Colombia.

Egg: Unknown.

Deutovum: Unknown.

Larva: Described in a subsequent section of this paper.

Protonymph: Similar to that of *T. alleei*.

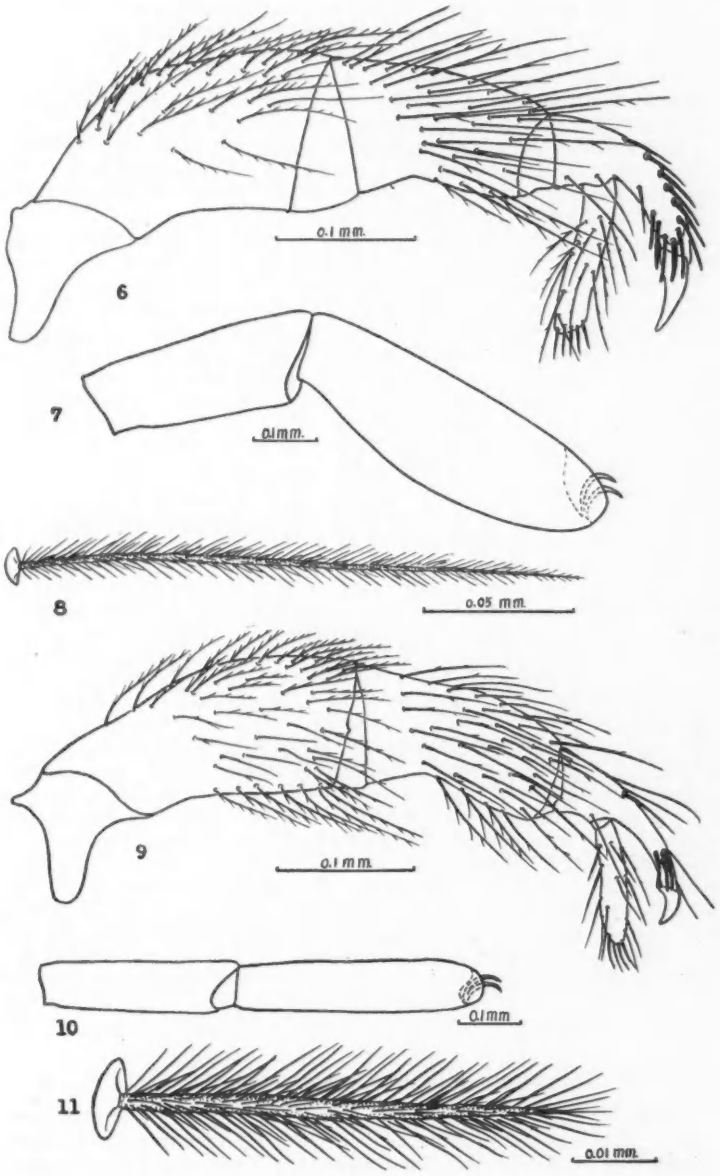
Nymph: Length (when freshly emerged) 0.09 to 1.0 mm. Older nymphs reach 1.5 mm. Similar to adult except for usual nymphal characteristics. Claw of pedipalp sometimes nearly half as long as tibia, which bears three to eight spines on inner surface. Body hairs sparser than in adult, those of posterior end of body two to three times as long as those of shoulders, longest hairs 0.09 to 0.14 mm. in length. Legs similar to adult, last segment of foreleg 1.50 to 1.60 (or in one specimen, perhaps abnormal, 1.75) times length of preceding segment.

Preadult: Unknown.

Bionomics: Adults, and occasionally nymphs, of this species have been collected in nearly every month of the year under stones and logs and in leaf mold, frequently in relatively dry situations, in contrast to the other species discussed in this paper.

EXPLANATION OF PLATE II

FIG. 6. Lateral view of pedipalp of adult *Trombicula velascoi*. 7. Last two segments of foreleg of adult *T. velascoi*. 8. Body hair of adult *T. velascoi*. 9. Lateral view of pedipalp of adult *Trombicula attenuata*. 10. Last two segments of foreleg of adult *T. attenuata*. 11. Body hair of adult *T. attenuata*.


0.1 mm.
6
7
0.1mm.
8
0.05 mm.
9
0.1 mm.
10
0.1mm
11
0.01 mm.

Eggs have not been seen. However, about forty-five larvae emerged during a two-day period from a jar containing sterilized earth and an adult female of this species.

The larval activity, degree of engorgement, effect on the host of larval attachment, duration of the protonymphal stage, and the number of molts all are described for *T. alleei.*

It is inferred from the numerous arboreal bird hosts that larvae of this species and *T. alleei* regularly climb trees in search of hosts. On one occasion four larvae of *T. velascoi* were collected on branches of a mango tree three to six feet above the ground.

The hosts in which larvae have been collected are listed below. The number following each species is the number of specimens of the host on which larvae of *T. velascoi* have been found. Each asterisk (*) indicates a host specimen from which larvae were reared to nymphs and the identification checked. As would be expected from the habits of the adults, there are no aquatic birds in this list, in contrast to that for *T. alleei.* In spite of the long lists of hosts, the selection of bird hosts does not appear to be completely random. Thus the large number of flycatchers in the accompanying list is not entirely due to the ease with which these birds can be shot. This is shown by the fact that some twenty tanagers of five species have been examined, some from the same trees where infested flycatchers were obtained, yet only one tanager had chiggers on it. Practically every flycatcher obtained had chiggers, either this species or *T. alleei* or both.

Sparrow hawk, *Falco sparverius* (1); domestic chicken, *Gallus gallus* (1); ani, *Crotophaga ani* (8); Rieffer's hummingbird, *Amazilia tzacatl* (1); black-breasted puff-bird, *Notharcus pectoralis* (1); red-crowned woodpecker, *Centurus subelegans* (1); black-crested ant shrike, *Thamnophilus doliatus* (2); white-bellied antcatcher, *Myrmeciza longipes* (2); Lawrence's woodhewer, *Xiphorhynchus guttatus* (2); Berlepsch's kingbird, *Tyrannus melancholicus* (8*); Cayenne flycatcher, *Myiozetetes cayanensis* (4*); Colombian vermillion-crowned flycatcher, *Myiozetetes similis* (13****); gray-capped flycatcher, *Myiozetetes granadensis* (2); western lictor flycatcher, *Pitangus lictor* (3); Panama flycatcher, *Myiarchus ferox* (3); pewee, *Myiochanes* sp.? (3); short-legged pewee, *Myiochanes cinereus* (1*); a small flycatcher, *Empidonax* sp.? (1); northern yellow-bellied elaenia, *Elaenia flavogaster* (1); Gould's manakin, *Manacus vitellinus* (1); Galbraith's wren, *Thyrothorus leucotis* (2); Panama wren, *Thyrothorus modestus* (1); Panama house wren, *Troglodytes musculus* (1); ocher-fronted hylophilus, *Hylophilus aurantiifrons* (1); warbler, *Dendroica* sp.? (1); southern dusky-tailed ant tanager, *Habia gutturalis* (1); Prevost's cacique, *Amblycerus holosericeus* (1); Panama black-headed saltator, *Saltator atriceps* (2*); Panama streaked saltator, *Saltator albicollis* (1); Hick's seed-eater, *Sporophila aurita* (1); Lafresnaye's sparrow, *Arremonops conirostris* (3); forest rabbit, *Sylvilagus gabbi* (1).

Trombicula (Megatrombicula) attenuata, n. sp.

Adult: Length 2.0 mm. (varying from 1.4 to 2.1 mm. among paratypes). Brilliant red in life. Claw of *pedipalp* measured along upper margin about 0.20 (varying from 0.19 to 0.23) times length of pedipalpal

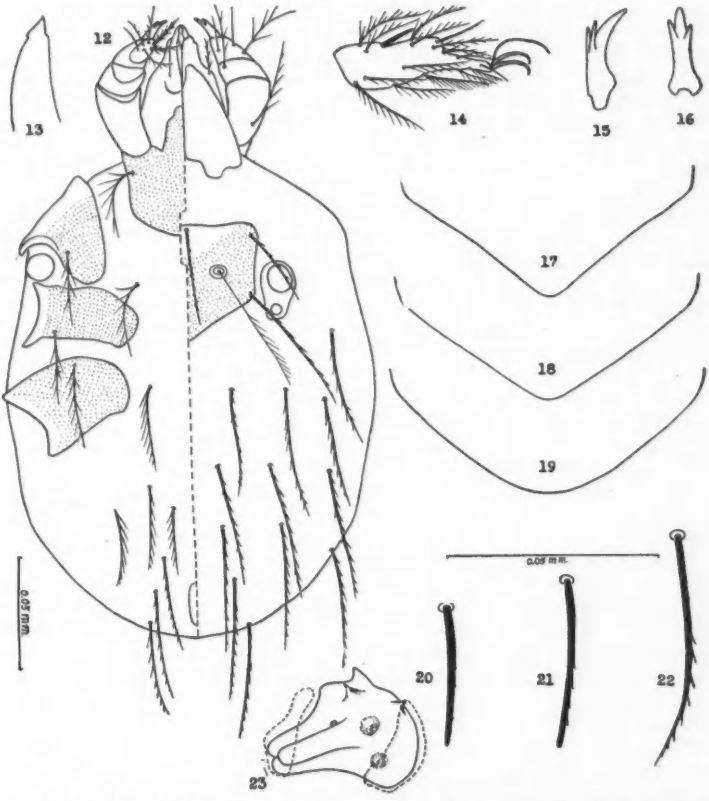


FIG. 12. Larva of *T. attenuata*, dorsal view on right, ventral on left. 13. Apex of chelicera of larval *T. attenuata*. 14. Anterior tarsus of larval *T. attenuata*. 15, 16. Lateral and dorsal view of pedipalpal claw of *T. attenuata*. 17–19. Outlines of posterior portions of dorsal plates of larval *T. attenuata*, *alleei*, and *velascoi*. 20–22. Submedian posterior marginal body hairs of larval *T. velascoi*, *alleei*, and *attenuata*. 23. Lateral view of deutovum of *T. alleei*. Broken lines indicate the position of the halves of the egg shell.

tibia, which is extraordinarily slender; inner surface of tibia with three blunt spines arising near (or basad of) middle of upper margin; finger of pedipalp with four or five short simple bristles apically, other hairs mostly simple. *Crista* about as in other species; pseudostigmatic organs simple, longer than crista. *Body hairs* but little longer at posterior end of body than on shoulders, plumose throughout lengths, longest body hairs 0.13 mm. (longest hairs varying among the paratypes from 0.05 to 0.13 mm.) long. *Legs* slender, anterior pair longer than body, others shorter; last tarsal segment of anterior legs not swollen, not thicker than preceding segment, about parallel sided (sometimes slightly thicker beyond middle or subapically than elsewhere), four and one-half (varying from four to over four and one-half) times as long as broad, 1.20 (1.19 to 1.25) times as long as preceding segment.

Holotype male and *allotype* female: Juan Mina, Canal Zone, Panama, September 12, 1945. Fifty-four adult *paratypes* from the same locality, August 15, September 12, and October 17. The holotype, allotype, and a series of paratypes are in the collection of the American Museum of Natural History, New York City. Additional paratypes will be placed in the collections of the United States National Museum, the Museum of Comparative Zoology, and the Gorgas Memorial Laboratory.

Egg: Diameter 0.16 to 0.18 mm. Red, spherical, smooth.

Deutovum: Similar to that of *T. alleei*.

Larva: Described in a subsequent section of this paper.

Protonymph, *Nymph*, and *Preadult:* Unknown.

Bionomics: This species has thus far been found only on floating plants of water lettuce, *Pistia stratiotes*, a few hundred yards up the Rio Hondo from the point where that stream enters the Chagres River. In this patch of *Pistia* plants it is not uncommon, although less abundant than two species of microtrombidiine mites which also live on *Pistia*. It is much more common than *T. alleei*, found occasionally in the same situation. The mites are found among the coarse hairs and ribs of the under surface of the leaves of the plants.

The eggs are laid in masses of twenty-five to about fifty on the under surface of *Pistia* leaves. The duration of the egg stage is about seven days, that of the deutovum seven to nine days.

Although various birds and mammals were shot near the *Pistia* patch where this species was found, larvae of *attenuata* were not found on any of them and the larval hosts remain uncertain.

A convenient method of handling eggs and deutova of this mite and others inhabiting *Pistia* and similarly moist places has been found and may be worth recording. Individual leaves or pieces of leaves decompose in a few days so that the eggs become imbedded in decomposing material. Keeping eggs on entire plants requires large aquaria and involves the additional disadvantages that unobserved eggs may be present and that when the eggs hatch the larvae will disperse over a large area of leaves and water surface. It was found convenient to place eggs in the middle of a piece of paper fitted into the bottom of a fruit jar. The bottom of the jar is slightly convex inside and a small amount of water is placed in the jar so that only the convex center projects above the water surface. A thin film of water will then extend

over the paper, covering the eggs. The paper can be easily removed from the jar with forceps for microscopic examination of the eggs or deutova, which stick to the paper because of the surface tension of the water. The jar is kept sealed to prevent evaporation of the water as well as the escape of the larvae.

LARVAE OF MEGATROMBICULA

Because of the great similarity of the larvae of the three known species of this subgenus, they are here dealt with in a separate section. All three species agree in the following characters:

Length 0.22 to 0.25 mm. when unengorged, increasing to 0.75 mm. when engorged. Color red. *Pedipalps* not strongly elbowed; first, second and third setae plumose, the number of branches varying somewhat but without regard to species, third with from two to six branches, fourth and fifth setae simple; claw of pedipalp slightly shorter than tibia, median prong conspicuously curved, lateral prongs arising about midway the length of claw, relatively straight, shorter and more slender then median prong, the inner prong slightly longer than the outer. *Chelicerae* with subapical tooth on convex margin, notch on concave margin; seta of chelicera with one to five branches. *Dorsal plate* punctate except for anterior median portion, slightly wider than long, the posterior margin strongly convex or medially angulate, anterior margin slightly concave on either side of median seta; anterior lateral seta about three-fifths as long as posterior lateral; pseudostigmatic organs densely plumose, situated much in front of middle of plate. *Eyes* situated close to dorsal plate, the posterior ones small and inconspicuous. *Body setae* of dorsum arranged as follows: 2–6–6–6–2–2, the lateral setae of fourth row and both setae of sixth row being marginal; ventral setae, not counting the usual four sternals, twelve. *Legs* with coxae (like coxal plate of pedipalps) punctate, the punctures in more or less definite rows; basal spine of last segment of foreleg arising a little more than length of spine from base of segment (this segment frequently more elongate than in fig. 14, there being variation in this character even in larvae from a single egg mass).

The distinctions between the three species of *Megatrombicula* known as larvae are very slight in spite of the conspicuous adult characters, and not every larva can be definitely placed in one species or another.

The posterior margin of the dorsal plate is angulate in *attenuata*, broadly rounded in *velascoi*, intermediate in *alleei* (figs. 17 to 19). Most specimens can be placed on the basis of this character alone, but some are intermediate. In *attenuata* the breadth of the dorsal plate is frequently less than in the other species (under 76 microns in *attenuata*, commonly over 80 in the others), but specimens of *alleei* and *velascoi* have been found rather frequently with plates as narrow as in *attenuata*.

The body hairs, including those of the dorsal plate, are longer, with more numerous and longer branches, in *attenuata* than in *velascoi* (in which the branches of the dorsal body hairs are often nearly wanting), with *alleei* occupying an intermediate position (figs. 20 to 22).

This character may be expressed more precisely in several ways. For example, the anterior lateral setae of the dorsal plate reach little

beyond the bases of the posterior lateral setae in ***velascoi***, much beyond in ***attenuata***. The length of the submedian posterior marginal body setae (sixth row of dorsal setae, as listed in the setal formula in preceding description) has been taken as an index of the length of the body setae. Table II shows frequency distributions of the lengths in microns of these setae in specimens clearly identifiable by the shape of the posterior margin of the dorsal plate. It is evident from this table that ***attenuata*** is clearly distinguishable from the others by this character, but that ***alleei*** and ***velascoi*** overlap broadly. This table has been helpful in identifying many specimens in which the posterior margin of the scutum was not clearly visible or was intermediate between the shapes considered typical for two of the species.

TABLE II

NUMBERS OF INDIVIDUALS OF THREE SPECIES OF *Trombicula* FALLING INTO VARIOUS CLASSES WITH RESPECT TO THE LENGTH OF THE SUBMEDIAN POSTERIOR MARGINAL SETAE

velascoi	5	12	21	12	1	1						
alleei			1	11	7	11	1	3				
attenuata											15	5
Length of hairs (μ)	34–35	36–37	38–39	40–41	42–43	44–45	46–47	48–49	50–51	52–53	54–55	56–57

It is interesting to note that on the basis of known larval characters it would be virtually impossible to determine that ***alleei*** and ***velascoi*** are distinct.

ACKNOWLEDGMENTS

The author is much indebted to the Gorgas Memorial Laboratory and especially to its director, Dr. Herbert C. Clark, for excellent facilities provided for this work. The assistance of Henry Van Horn, a Laboratory employee, in obtaining bird and mammal chigger hosts was invaluable. Thanks are also due to Major Marshall Hertig, Sn.C., and Captain G. B. Fairchild, Sn.C., for their assistance and helpful suggestions, and to Mr. Thomas E. Gillard of the American Museum of Natural History for correcting the nomenclature used for the birds.

Special acknowledgment is due to Captain Roy Melvin, Sn.C., who investigated chiggers in Panama prior to my studies and who collected a few of the adults and nearly half of the larvae studied in the preparation of this paper.

The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Gorgas Memorial Laboratory, Panama City, R. de P.

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TAXONOMIC STUDIES OF NEARCTIC CRYPTINI (ICHNEUMONIDAE, HYMENOPTERA), by HARRY DAVIS PRATT. American Midland Naturalist, Vol. 34, No. 3, pp. 549–661. Notre Dame, Indiana, 1945.

Dr. Pratt's study is an excellent addition to the literature of the parasitic Hymenoptera. He evidently examined an enormous amount of material in the course of his work, and by condensed references he summarizes the location of this material under each species. In the comprehensive treatment of taxonomic data his contribution is scholarly.

With the exception of a brief introduction and a few pages of notes on larvae, including a key to some of the latter as a suggestion of significant characters, the article is wholly taxonomic. The tribe is considered historically and a key to the Nearctic genera is included. Beyond this material the article contains a description of a new genus, *Nasutocryptus*, type *N. nasutus* n. sp., and a key to the Nearctic species of *Cryptus* followed by descriptions of the included species, of which thirty-one are described as new. The plates are made up of excellent figures of wings, genitalia and larval structures with a few other details. A peculiar irregularity is noted in format, in that headings for new species are set in bold-face and those of previously established species in caps and small caps with the exception of a few in bold-face—an item which only an editor might notice. Most entomologists are, no doubt, familiar with the clear and attractive format of the Journal and the excellent quality of the printing.—A. W. L.

LA VIE DES SAUTERELLES, by L. CHOPARD. 204 pages, 15 text figures, 18 half-tone plates. No 6 in a series entitled Histoires Naturelles, published by the Librairie Gallimard, Paris. Price 150 francs.

This attractively written little volume is a companion of *La Vie des Scarabées*, reviewed a year ago, and shares with it the good printing and poor paper of the familiar paper-bound French books. The quality of the plates is reasonably good.

The title is somewhat misleading, since other Orthoptera than the Locustidae are considered, and the earwigs are treated as a group in this order. Contents include chapters on the order in general, on form and habitats, sound, metamorphosis, individual life, reproduction, and relations to man. Like the other books of the series this is a semi-popular work and is an interesting and rewarding volume for anyone who is not a specialist on Orthoptera. It should be a valuable aid to facility in French for anyone interested in insects.—A. W. L.

A NEW GENUS (EXCAVANUS) AND SPECIES OF MEXICAN LEAFHOPPERS RELATED TO ACUNASUS

(Homoptera: Cicadellidae)

DWIGHT M. DELONG,
Department of Zoology and Entomology,
Ohio State University

Genus **Excavanus** nov.

Apparently related to *Acunasus* but with a narrower head and a simple type of venation of the fore wing. Vertex short and broad, decidedly narrower than pronotum. Margin thin and foliaceous, disc deeply broadly excavated. Pronotum strongly roundedly produced anteriorly, and strongly, broadly emarginate posteriorly, disc with conspicuous transverse striae. Elytra long and rather narrow, venation simple.

Genotype *Excavanus angustus* n. sp.

Excavanus angustus n. sp.

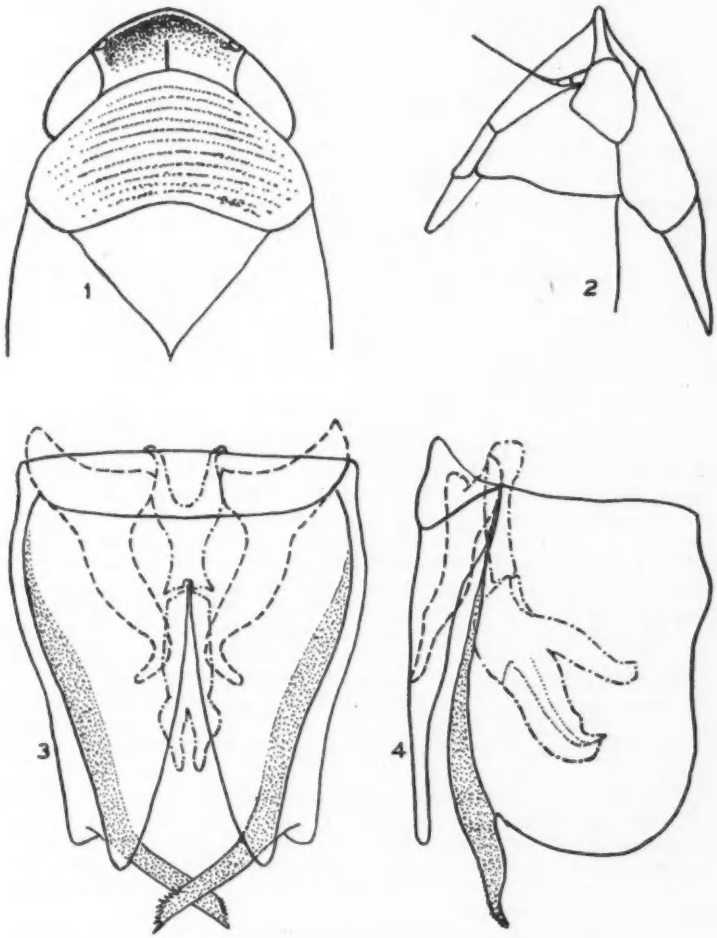
Superficially resembling a narrow species of *Gyponana* but with ocelli on margin of vertex next eyes with excavated vertex disc and distinct genital structures. Length, male, 7.5 mm.

Vertex rather strongly roundedly produced a little longer at middle than next the eyes, two and one-half times as wide between eyes at base as median length. Pronotum decidedly wider than vertex with prominent, angled humeral angles. Scutellum comparatively large with a transverse impressed line on posterior portion of disc. Venation of elytra simple.

Color pale brown with a pair of faint darker spots at apex. Posterior portion of scutellum paler. Face and beneath yellowish.

Genitalia male plates elongate, triangular, apices blunt. Style long, the apex is narrowed and bent outwardly. The aedeagus in ventral view is cleft on apical third. In lateral view it appears in the form of a "V" with a slender anterior arm and a much broader posterior portion. The latter is broadly curved on ventral margin at base and is curved on caudal margin at apex forming a bluntly pointed tip. A long spine arises at base of pygofer on either side and extends along inner margin to apex where it bends upwardly. The inner apical margin is serrate.

Holotype male, collected at Iguala, Gro., October 25, 1941, by E. E. Good and the author. Type in author's collection.



Excavanus angustus n. sp.

FIG. 1. Dorsal view of head and pronotum. 2. Lateral view of head and pronotum. 3. Ventral view of male genitalia. 4. Lateral view of male genitalia.

WAR LOSSES AMONG INSECT COLLECTIONS AND ENTOMOLOGISTS IN JAPAN

CHARLES L. REMINGTON,
Cambridge, Massachusetts

Entomologists carrying on studies including Oriental insects have felt some concern over possible damage to Japanese insect collections, particularly to types. The numerous American entomologists who have corresponded with Japanese specialists and collectors will find useful a report on casualties from war action among entomologists. In October, 1945, the writer participated in early landings by occupying United States troops and during his three months in Sapporo, Hokkaido, was able to assemble information on the extent of destruction to insect collections and casualties among entomologists in Japan, largely through the kind aid of Professor T. Uchida and Dr. C. Watanabe.

I. COLLECTIONS

The three great Japanese insect collections were: (1) the enlarged Matsumura Collection at the Hokkaido Imperial University; (2) the collection built by Professor Esaki at the Kyushu Imperial University; and (3) the collection at the Taihoku Imperial University on Formosa, the fruit of Professor Shiraki's labors. The Hokkaido and Kyushu collections are entirely undamaged and have received continuous care. Because of severance of connections between Japan and Formosa and lack of U. S. troops on that island, it has been difficult to obtain information about the collection at Taihoku. However, it appears that the great Imperial University escaped the heavy bombardment. Through information from a refugee from Formosa, the writer believes that the insect collection came through unharmed. Each of these three important insect collections is accompanied by an extensive library, complete for Japanese publications and with foreign books and journals well represented.

The small, specialized insect collections at the Imperial Universities of Kyoto and Tokyo; the agricultural colleges at Morioka, Tokyo, Miye, Taichu, Ehime, Miyazaki and Hirosaki; and the experiment stations at Kotoni, Sapporo and Tokyo are undamaged. The well-known private collections of Takeuchi, Nawa, H. Kono, Sugitani, and Tosawa escaped destruction.

Thus, most of the insect collections in Japan, with their numerous types, were undamaged. However, there were two notable exceptions, both in Tokyo. Incendiaries completely destroyed the extensive slide collections of parasitic mites and mosquito pupae prepared by Y. Asanuma at the Research Institute of Natural Resources. Few if any types were lost, because Asanuma's studies were in manuscript form, unpublished as a result of discontinuance of entomological periodicals in Japan during the War. The tragedy for Mr. Asanuma is that his manuscripts reporting the results of his researches on rat mites and

mosquito pupae were said to be completely destroyed by the fire. K. Nomura's collection of Lepidoptera was consumed in the same fire.

The other loss to incendiary raids on Tokyo was the collection of the Tokyo College of Agriculture, which contained the large number of aquatic Coleoptera assembled by Dr. K. Kamiya. Dr. J. Linsley Gressitt has informed me that types of aquatic Coleoptera and some Staphylinidae were destroyed with this collection.

No definite information was available as to the condition of the collections of the experiment stations at Taihoku and Tainan on Formosa, or Konuma, Sakhalin. The Formosa collections are with the insect collections at Taihoku Imperial University. They are said to include Dr. Takano's Tachinidae, Dr. Miwa's huge collection of Oriental Elateridae, and numerous other Coleoptera. Loss of these collections with their scores of types would be a blow to entomology in the Orient, but, like the Shiraki collection, all of them are believed safe.

F. G. Werner reports (in litt.) that he visited the Korean national collection in the National Science Museum at Seoul and found it intact. The curator is Pok Seong Cho, formerly of the Nanking Central Museum in China. The Korean Museum contains an excellent butterfly collection. The Forestry Station in Seoul, with a large insect collection, is also unharmed.

The scientific collection of the Central National Museum of Manchukuo at Hsinking contained not only recent insects but a number of fossils. The treatment of the museum at the hands of the Russian occupation forces is unknown.

II. ENTOMOLOGISTS

Among entomologists there were no casualties from the bombing of the Japanese home islands. However, the deaths of three able Japanese entomologists since the outbreak of hostilities should be mentioned.

Dr. J. Shibuya was killed during bombardment of Rota Island in the Marianas. He was a civilian on Rota working in the capacity of an entomologist. He attained high rank among Japanese entomologists for his studies of the moths of the family Pyralidae over many years.

Dr. Y. Niijima, Professor Emeritus of the Hokkaido Imperial University and an authority on Coleoptera and Forest Entomology, passed away quietly on February 6, 1944, at his home in Sapporo.

Dr. M. Matsushita, a specialist on Cerambycidae, passed away on October 10, 1944, at Asahigawa, Hokkaido. Dr. Matsushita was a relatively young man but had been suffering from a serious disease.

Certain entomologists were serving in civilian status in various occupied territories when those places were assaulted and retaken by Allied forces. The fate of these scientists is unknown. Some of them were well known to American entomologists.

Dr. R. Takahashi, whose works on Formosan Aphididae are in many American libraries, was at Kuala Lumpur in Malaya.

A. Kawada, a Japanese Lepidopterist, former entomologist of the Imperial Experiment Station near Tokyo, was on the island of Java.

S. Kato, Assistant Professor of the Peking University, was at Peking, China, at the time of the Japanese surrender.

K. Sato, Hymenopterist and former Assistant of the Division of Japanese and Asiatic Beetles, of the U. S. Bureau of Entomology and Plant Quarantine, was outside of the Japanese home islands, and his present location is unknown.

Five entomologists had been in Manchuria when the Russian armies launched their offensive there, and their fates are unknown. They were K. Oike, student of Cicindellidae; J. Murayama, Ipidae; S. Kariya, Tipulidae, S. Ashina, Odonata, and T. Tsuchiya, Economic Entomology.

I. Okada, specialist in Nematocerous Diptera, especially Mycetophilidae, was entomologist of the Agricultural Experiment Station at Koshurei, Manchukuo. He escaped from there and has returned to Japan.

It was impressed on the writer that the greatest losses to entomology from the devastating raids on Japan were not among the entomologists or the collections, but rather the literature. With few exceptions the countless booksellers and publishers of Tokyo and the smaller cities were burned out completely. However, Dr. J. L. Gressitt reports that Jimbo-cho and Hongo, large bookstores in Tokyo, were not burned, but their stocks are greatly depleted by being bought out. Thousands of books and periodicals were lost and many books once readily obtainable are now rare and cannot be bought for a reasonable price. In the case of books published only a few years ago, the publishers still had large stocks when the fire bombs fell, and most of these stocks were completely destroyed.

PAPÉIS AVULSOS DO DEPARTMENTO DE ZOOLOGIA, VOL. VI. Pages iv+338, 1945. Secretaria da Agricultura, São Paulo, Brazil.

This volume includes twenty-three articles, most of them on insects and many continuing the reports on the fauna of the Monte Alegre district. The exceptions are a short article by C. C. Vieira on mammals, one on birds by Olivério Pinta, five by B. M. Soares on phalangids and one by Otto Schubart on diplopods.

The articles on insects deal with the orders Lepidoptera, Coleoptera, Diptera, Hymenoptera, Orthoptera and Mallophaga. Most of them are lists of species with varying amounts of bibliographic material and annotation. Two by E. Navajas on Elateridae and Fulcidacidae include descriptions of new species, as also do P. J. Moure's article on bees, L. R. Guimarães' article on the biting lice of the tinamous, and Charles P. Alexander's article on Tipulidae. The articles on other arthropods also contain descriptions of new species.

Lauro Travassos' article on the dates of publication of the "Melanges Orthopterologiques" of Henri de Saussure will be of interest to students of that order.

The series of Papéis Avulsos, of which Vol. V is delayed, indicates important progress in the study of the rich Brazilian fauna.—A. W. L.

APOLYSIS, OLIGODRANES AND EMPIDIDEICUS IN AMERICA

(Diptera, Bombyliidae)

A. L. MELANDER,
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These small flies have had a confused history. In 1886 Bigot described *Rhabdopselaphus mus*, a new genus and species from California, but mistakenly credited it with having three submarginal cells. Williston, in the supplemental notes to his last Manual of Diptera, having examined Bigot's type, announced that the fly has only two submarginals. Coquillett in a series of papers, 1892, 1894 and 1902, published five new species, locating them in the genus *Geron*, and these were removed by Cresson in 1915 to a new genus, *Pseudogeron*, which he was erecting for them and for eight new species from the Southwestern United States. A few months later Cresson announced the identity of *capax*, one of the species described by Coquillett in 1892, with *Rhabdopselaphus mus*, and the synonymy of *Pseudogeron* with *Rhabdopselaphus*.

Rhabdopselaphus was based essentially on having blunt antennae and long slender palpi, thus differing from *Geron*. *Oligodranes*, founded by Loew in 1844, was characterized the same way, the palpi, however, being two-jointed with the apical joint short. There were two original species of *Oligodranes*, from Asia Minor, one with long palpi and the other with short palpi, and in 1875 Loew added a third species, *modestus*, from Turkestan, at the time expressing uncertainty as to the structure of its palpi. Paramonow, in 1929, when adding a Transcaspian species to *Oligodranes*, stated that fresh material of Loew's third species had short single-jointed palpi, and suggested therefore that it be considered as an aberrant species of *Usia*, which belongs to a different subfamily of the Bombyliidae. Recently Engel has described another species from the Caucasus, and decided that Loew's *modestus* is a transitional species between *Usia* and *Oligodranes*. From the point of view of phylogeny it is difficult to visualize how a highly specialized species can be transitional, i.e., ancestral or palingenetic, between groups so diverse as to be given subfamily rank. Hesse had added two more species to *Oligodranes* from South Africa, in which the segmentation of the palpi is scarcely discernible. The American species before me which would be placed in *Rhabdopselaphus* all have single-jointed palpi, though at least in the new species *retrorsus* there is sometimes an indication of segmentation. In length and structure the palpi show extreme variation, ranging from long and thin to very short and stubby.

In 1923 Cole published two species as of *Rhabdopselaphus*, one of which had an open discal cell. He announced that he had another but undescribed species with this same peculiarity. My own collection has eight species with the discal cell open, so the character is not due to individual aberration of the *Rhabdopselaphus* neuration but is validly

phyletic. However, see the remarks on *Apolysis disjuncta* following the description of this insect. The nine American species bear exactly the same relation to the Old World *Apolysis* that *Rhabdopselaphus* does to *Oligodranes*, i.e., one-jointed vs. two-jointed palpi. *Apolysis* was erected by Loew in 1860 for a species which is widely spread in Africa. Two other species of *Apolysis* occur in the Mediterranean region and six more in South Africa. There is no doubt that *Apolysis* is a recent derivative from *Oligodranes*, specialized by the loss of the posterior crossvein, just as the single-jointed palpi of the American species of both genera are to be regarded as reductions from an earlier two-jointed condition.

As to what names to apply to the American species two lines of argument present themselves. (1) If emphasis be placed on the number of segments of the palpi then the Old World genera *Oligodranes* and *Apolysis* are distinct from the New World *Rhabdoselaphus* and an unnamed genus corresponding to *Apolysis*. In that case Paramonow and Engel were justified in removing Loew's third *Oligodranes*, but whether it should go to *Usia*, *Rhabdopselaphus* or to a new genus remains unsettled. (2) If the instability of palpal structure be recognized there appears to be no reason for keeping the American species of *Rhabdopselaphus* distinct from the Old World *Oligodranes*, where they would key in the tables of Schiner, Becker, Verrall, Engel and Hesse, and those species having an open discal cell would all be included in *Apolysis*. Commenting on the number of joints in the palpi of *Gonarthrus* in his exhaustive monograph of South African Bombyliidae, Dr. Hesse has stated that this is not a differentiating generic character in the Bombyliidae, because in many genera species with superficially unjointed palpi show the plane of separation into two segments when treated with caustic potash or creosote.

In as much as generic boundaries are only matters of personal interpretation it appears, in the mind of the present writer, that the simplest expedient is to adopt the second course, and to extend to the American Continent the distribution of *Oligodranes* and *Apolysis*. This decision is supported by the great range of other taxonomic characters in these flies, which makes it difficult to establish generic limits. Much stress has been laid on the development of the "occipital schwielen," a raised longitudinal welt on each side of the neck, and on the depth of the V-shaped groove behind the ocelli. Judged by these characters the species *cinctura* Coquillett with its strong welts should certainly be a *Usia*, though the other species show a complete gradation to an almost smooth occiput, which is the condition of the European *Oligodranes*.

In the Southwestern States there appears to be almost an endless number of species of *Mythicomyia* and of the three genera of this paper. The flies are strictly anthophilous, mostly frequenting arid districts and locally appear to be quite common, though because they include some of the smallest forms of the Bombyliidae they are easily overlooked. The habits of the adults are the same in Europe, Africa and America. Nothing is known of the earlier stages. Collecting in near-by canyons extending along the San Bernardino Mountains and San Jacinto Mountain discloses an isolation that has resulted in the production of

local species, suggesting Gulick's classic illustration of species formation for land snails in the mountain valleys of the Hawaiian Islands. Of the hundreds of California specimens before me it has been difficult to find full agreement with any of the species described from New Mexico. There is only one species with extended distribution, *sigma*, but as Cresson has suggested, it is not certain that the specimens from Maryland, Florida, Alabama, California and Washington are of monophyletic origin. *Sigma*, like the other species, exhibits variability, but since the variations are not of tangible specific importance the group must be treated as a single taxonomic species.

The large number of species and their restricted local distribution indicate a youthful group, biologically considered. This is further borne out by the extent of variability often encountered in series of specimens of a kind as well as by the small differences when comparing specimens from several localities. There may be a considerable range in color and in neuration, which must be considered when making identifications from the key and from the descriptions which are based on the type specimen. The exact location of the anterior crossvein, the length and placement of the second submarginal cell, the extent of the second vein, and the proportions of the sections of the fourth and fifth veins are neurational characters not absolutely fixed, yet within limits they are important indices for the placement of species.

Many of the species are markedly dimorphic in the sexes, so that the association of males and females often is dependent on the locality and date labels they bear rather than on a similarity in conformation. To add to the difficulty in making determinations it often happens that color patterns of pollen are completely obscured by greasiness, which also accentuates the yellow fasciae along the abdominal incisures. Contraction of the abdomen upon drying decreases the visible extent of dark bands at the base of the segments and gives the impression that the abdomen as a whole is colored more like the pale apical part of the individual segments. Since color patterns are due mainly to the superficial coat of pollen microscopically slanting in various directions the appearance changes with the angle of view. For best effects the thorax should be viewed from in front and a little to one side, and the abdomen from behind. The important triangle of pollen just above the antennae of the male can give a misleading impression of color if the front is wrinkled on drying. The male genitalia are small and are likely to be twisted, retracted or eviscerated, hence are of little value to the museum taxonomist. But to compensate for the difficulties in making determinations these flies do not possess a coating of easily rubbed tomentum. Even the hairs are not as loosely attached as in other pilose Bombyliidae. The location of abraded hairs is indicated by minute dark dots showing in the pollinose coating.

The following keys, based upon my own collection and the tabulation of *Pseudogeron* given by Cresson, appear to be quite workable for most of the specimens before me. Nine of the previously described American species are not represented, but have been included in the keys from data in their diagnoses. How well the tables will serve for collections from other localities remains for the future to determine. Probably in view of the great plasticity of the group very many more

species await discovery and will cause numerous interpolations in the tables. I am withholding a few additional species of *Oligodranes* which I have taken in Southern California, represented only by females, but which lack characters of sufficient taxonomic importance to warrant their announcement at this time. Unless otherwise indicated, the insects described in the following pages were all taken by myself and the types are located in my collection. The collection of the Citrus Experiment Station of the University of California has furnished important data as well as five additional new species. For condensation, in printing, characters enumerated in the tables are not repeated in the diagnoses.

Among the minute Bombyliidae swept from desert flowers are three species unquestionably belonging to the genus *Empididеicus*, which was erected by Becker in 1907 for a species from Tunisia, North Africa. This genus possessed the greatest reduction in neuration in the Bombyliidae, having the auxiliary vein vestigial, the second vein fused with the first, a simple unbranched third vein, the discal cell open due to the loss of the posterior crossvein, and the ambient vein undeveloped.

Other species of *Empididеicus* have since been recorded: *E. hungaricus* Thalhammer, 1911, from Hungary and Corsica; *Efflatouni* Engel, 1933, from Egypt and Turkestan; and *Turneri* Hesse, 1938, from South Africa. Bezzi, in 1926, transferred his *E. nubilis* to *Cyrtosia*, placed his *Glabelula mellea* in *Empididеicus*, and mistakenly removed Brunetti's *E. indicus*, 1917, to *Glabellula*. The net result is that *Empididеicus* now includes one European species, five African, one Indian, and the three American species described herewith.

The relationships of the three genera of this paper to their nearest relatives and to the other Bombyliidae are indicated by the following tabulation.

A. Third vein not forked, therefore one submarginal cell, four posterior cells, anal cell almost always open, no alula.
  B. Second vein short, or imperfect, or wanting; hunchbacked species. (**GLABELLULINAE** Cockerell, 1916) **MYTHICOMYIINAE** Melander, 1902
    C. Second vein vestigial, fused with first, or absent. (If second vein forms a small marginal cell the discal and third posterior cells are confluent). Basal cells nearly equal, ambient vein very weak.[1]
      D. Discal cell fused with third posterior cell.
        E. Anterior ocellus in front of others; abdomen scarcely wider than thorax. (Eur., Asia, Afr. N. Am.).....**Empididеicus** Becker
        EE. Anterior ocellus in line with others; abdomen flattened, wider than thorax. (N. Afr.).....**Cyrtoides** Engel
      DD. Discal cell complete. (Afr.).....**Anomaloptilus** Hesse
    CC. Second vein very short but well formed, ending in first vein almost like a crossvein, forming a short triangular marginal cell.
      D. Discal cell complete; male holoptic. (N. and S. Am.), **Mythicomyia** Coquillett
      DD. Discal cell confluent with the large second basal; male dichoptic. (Eur., India., Austr., N. Am.) (*Pachyneres* Greene)..**Glabellula** Bezzi
  BB. Second vein normal, ending independently in costa beyond first vein, therefore marginal cell long, second basal cell usually much shorter than first.....**CYRTOSIINAE**

[1]Dr. Hesse has proposed the name *Doliopteryx* for another genus in this group. The description was to appear in the Appendix to Part II of his exhaustive revision of the Bombyliidae of South Africa, but has not yet been published.

C. Discal cell open, no posterior crossvein, second posterior cell peduncu-
late.
D. Anal cell open, axillar lobe narrow.
E. Second vein ending much closer to first than to third, anterior crossvein beyond middle of wing; proboscis shorter than head (Tasmania).....**Cyrtomorpha** White
EE. Second vein ending midway between first and third; proboscis as long as head or longer.
F. Head more or less spherical or oval. (S. Eur., W. Asia, N. Afr.) (*Cephalodromia* Becker).....**Cyrtosia** Perris
FF. Head elongate, occiput large and convex, produced back below. (S. Afr.).....**Ceratolaemus** Hesse
DD. Anal cell petiolate, axillar lobe full, second vein ending near first. (S. Afr.).....**Onchopelma** Hesse
CC. Discal cell complete, omitting three veins; male dichoptic.
D. Proboscis as long as head or shorter; first basal cell longer than second. (Eur., W. Asia).....**Platypygus** Loew
DD. Proboscis longer than head; occiput large, strongly produced posteriorly below. (S. Eur., N. Afr.).....**Cyrtisiopsis** Seguy
AA. Third vein forked, two submarginal cells, second vein always ending in costa, alula usually lobate. (If three submarginal cells: many genera.)
B. Only three posterior cells. (If abdomen and legs long and slender: **SYSTROPODINAE**.)
C. Third antennal joint blunt with minute sensory thorn or style in a small sulcus above tip; hairs of cheek not curving forward. (If body broad with short abdomen: **USIINAE**).....**PHTHIRIINAE,** part
D. Discal cell complete. (S. Eur., W. Asia, S. Afr., N. Am.) (*Rhabdopselaphus* Bigot, *Pseudogeron* Cresson).....**Oligodranes** Loew
DD. Discal cell open with second posterior, no posterior crossvein. (S. Eur., W. Asia, Afr., N. Am.).....**Apolysis** Loew
CC. Third antennal joint long, subulate, pointed, with terminal style; genal hairs curving forward; eighth tergite of female with lappet. (Cosmopolitan.) (*Empidigeron* Painter.) **GERONINAE. Geron** Meigen
BB. Four posterior cells; many genera.

KEY TO THE AMERICAN SPECIES OF EMPIDIDEICUS

1. Second vein vestigial, no marginal cell, basal cells coextensive, veins largely thin and pale, anal lobe wider than anal cell; tibiae and knees yellow; no yellow spot above front coxae.....2
Second vein distinct, curving to meet the first vein, second basal cell shorter than first basal, veins black, anal lobe no wider than anal cell; legs black; a conspicuous bright yellow spot above front coxae, as well as humeri and postalar callosities bright yellow. (Cal.).....**propleuralis**
2. Scutellum and a large apical dorsal spot on abdomen luteous; sides of thorax yellow from humeri to postalar callosities. (Cal.).....**scutellaris**
Scutellum black, abdomen black with the incisures narrowly yellow; humeri and notopleural suture yellow (male), or humeri, broad notopleural mark and postalar callosities yellow (female). (Cal., Ariz.).....**humeralis**

Empidideicus humeralis n. sp.

Male.—Length 1.35 mm. Face very small, the mouth-opening excavated almost to the antennae, the narrow orbits and cheeks shining black and bare; occiput quite bare, shining below; eyes contiguous all along the front, the facets of upper two-thirds scarcely larger than the lower ones; antennae apparently two-jointed, the basal joint minute, the apical joint short-ovate, scarcely longer than wide, style thick, as long as the apical joint and tipped with a thin section; proboscis as long as head, oblique, thick, palpi not visible. Thorax shining black, the humeri white, very thinly cinereous dusted on sides and pleura, bare

except for a few microscopic hairs about shoulders and on dorsocentral rows, notopleural suture very narrowly yellow. Abdomen black, the side and posterior margins of the segments very narrowly yellowish, hairs white; two dorsal digitate valves overlapping the open pygidium. Knees, tibiae and base of metatarsi pale yellow, femora otherwise black, tarsi piceous. Wings whitish hyaline, anal lobe full, semicircular, veins pale, the third and sixth veins and crossveins strongest, ambient vein very weak, auxiliary vein thin and barely attaining costa, second vein wanting, indicated by a pale yellowish coloring adjacent to first vein, petiole of fourth vein a little shorter than second posterior cell which is not wider than first or third on margin, anal cell widely open; halteres white, the base of the stalk fuscous.

Female.—Front one-half longer than wide and with a pair of confluent yellow spots above antennae; face yellowish immediately below antennae, half as long as front. Sides of mesonotum in front of transverse suture and the posterior calli yellow. Basal segments of abdomen wholly black, last ventral segments swollen. Anal lobe of wing smaller than in male.

Holotype and allotype.—Tahquitz Canyon, near Palm Springs, California, 23 April, 1944. *Paratypes*—A male and a female, 24 March 1935, and two males and three females 10 April, 1946, also from Palm Springs; a male, Sheep Creek Canyon, near Phelan, California, 24 May, 1945; and a female, Wellton, Arizona, 6 April, 1935.

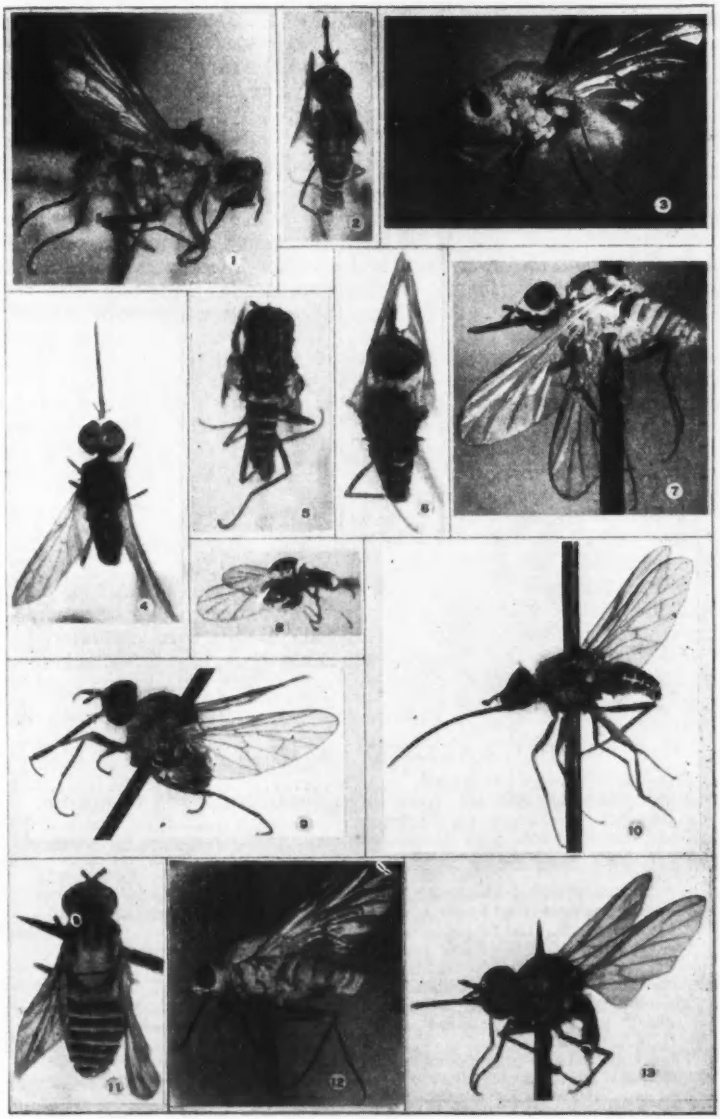
Empidideicus scutellaris, n. sp.

Figure 8

Length 1.2 mm. Head shining black, front broad, transversely yellow above antennae, widened behind, at front ocellus as wide as long and equalling the width of an eye, face yellow, vertical, the central part above the small mouth-opening as long as front, cheeks horizontal, occiput bulbous and without weals. Antennae as in ***humeralis***, proboscis about half as long as head-height. Thorax with scattered microscopic hairs, the humeri and sides both above and below the notopleural suture to the transverse suture and below the notopleural line to base of wing bright yellow, postalar calli narrowly yellow; mesopleura and pteropleura polished; scutellum black at very base. Abdomen nearly bare, shining black, side membranes yellow, the luteous apical spot rounded and extending over last four segments; genitalia inflexed under abdomen, longitudinally sulcate. Apical third of femora and all of tibiae and metatarsi yellow. Wings hyaline, venation as in ***humeralis*** but the fourth vein transparent from anterior crossvein to middle of second posterior cell, auxiliary vein absent, second vein fused with the swollen flavous end of first vein; halteres completely flavous.

EXPLANATION OF PLATE I

FIG. 1, ***Oligodranes maculatus***, n. sp., female; 2, ***longirostris***, n. sp., male; 3, ***comosus***, n. sp., female; 4, ***sipho***, n. sp., male; 5, ***pulcher***, n. sp., male; 6, ***loricatus***, n. sp., male; 7, ***togatus***, n. sp., female; 8, ***Empidideicus scutellatus***, n. sp.; 9, ***Oligodranes lasius***, n. sp., male; 10, ***cinctura*** Coquillett, male; 11, ***trifidus***, n. sp., female; 12, ***retrorsus***, n. sp., female; 13, ***Apolysis druias***, n. sp., male.



Types.—Three specimens taken 12 May, 1944, by sweeping flowers at the base of Piute Butte in Western Mojave Desert, California.

Were it not that the Old World species of ***Empididecus*** have dichoptic males the present specimens would be supposed to be females. The structure of the abdominal terminalia is difficult to understand, being unlike that of either sex of ***humeralis***.

Empididecus propleuralis, n. sp.

Length 1.4 mm. Shining black, the thorax marked with conspicuous light-yellow spots covering the humeri, postalar callosities, propleura and upper edge of the sternopleura and pteropleura. A pair of vertical spots on lower front and the face luteous; antennae as in ***humeralis:*** proboscis slightly shorter than head. Scutellum with six minute marginal hairs. Abdominal incisures very narrowly whitish, vestiture microscopic and brownish. Wings hyaline, the first, third and sixth veins strongest, anal lobe obtusely rounding, second basal cell shorter than the first by the length of the anterior crossvein, auxiliary vein firm but evanescent at three-fifths the length of the costal cell, second vein swinging free from the first to end in the latter before its tip, last section of fourth vein arching forward, the second posterior cell wider on the margin than either the first or third posterior cells; knob of halteres large and almost white.

Types.—Three specimens, collected 16 June, 1945, near the junction of the South and East Forks of the Santa Ana River, in the San Bernardino Mountains, California, elevation 6250 feet.

The arrangement of the second vein to form a small marginal cell is much like that of ***Mythicomyia*** and probably indicates a closer relationship with that genus than the open discal cell does with ***Empididecus***. It would seem then that ***Empididecus*** is a polyphyletic artificial genus, but it is more expedient to place ***propleuralis*** here than to erect a new genus for it.

KEY TO THE AMERICAN SPECIES OF APOLYSIS

1. Body black, more or less shining 2
   Body opaque or pollinose; second submarginal cell about as long as its petiole 4
2. Body shining or subshining black; veins dark. (Cal.) ..... **disjuncta**
   Body glistening black; veins pale 3
3. Anterior branch of third vein at wing-tip, last two sections of third vein of male proportioned about 3 : 1, of female 3 : 2, second vein of male ending opposite basal fourth of second submarginal cell, of female at basal third; 1.4 mm. (Cal.) ..... **petiolata**
   Posterior branch of third vein ending at wing-tip, last two sections of third vein of male proportioned about 3 : 2, second vein ending near basal third of second submarginal cell; 0.75 mm. (Cal.) ..... **minutissima**
4. Thorax of male silvery gray pollinose, abdomen densely cinereous; legs black except knees, base of tibiae and base of metatarsi yellowish; 1.2 mm. (L. Cal.) ..... **pygmaea** Cole
   Thorax not silvery gray pollinose, if cinereous the abdomen is flavous or the tarsi all black 5
5. Ambient vein stopping abruptly at fifth vein, first basal cell distinctly longer than second; thorax cinereous, nearly or quite bare species. (If ambient vein is complete, abdomen of female mostly yellow and legs black, see *Oligodranes instabilis*) 6

Ambient vein continuing beyond fifth vein though weak, basal cells of same length; thorax of male opaque black with cinereous markings in front, abdomen and legs black; face, cheeks, body and femora loosely pilose. (*druias* female: thorax vittate and maculate, abdomen opaque black with white fasciae) 8

6. Abdomen of female black in ground color, heavily cinereous, incisures white; tibiae black except extreme base; 3 mm. (Cal.) ..... **glauca**
Abdomen of female yellowish; anterior tibiae yellowish; less than 2 mm. 7
7. Petiole of anal cell as long as the cubital vein closing it; 1.5 mm. (Cal.), **timberlakei**
Petiole of anal cell half as long as the cubital vein closing it; 1.8 mm. (Cal.) ..... **mohavea**
8. Anal cell closed and petiolate; third antennal joint deeply excised above tip and with an obliquely upright thorn; 2 mm. (Cal.) ..... **druias**
Anal cell barely closed in the margin and not petiolate; third antennal joint only somewhat obliquely truncate above tip, thorn invisible; 2.3 mm. (Cal.) ..... **aperta**

Apolysis aperta, n. sp.

Male.—Length 2.3 mm. Body wholly black, not shining, loosely but conspicuously white-pilose, the hairs longest on underside of the head. First antennal joint one-half longer than the second, third one-half longer than the basal two together, elongate oboval, widest slightly beyond the middle; rounded at tip, the pit shallow and circular, thorn microscopic; proboscis straight, porrect, twice the head-height, palpi very thin, black, extending along one-fourth of the proboscis. Apical segments of abdomen thinly dark cinereous, no indications of fasciae, terminal pygidial valves pale. Knees very narrowly fuscous. Wings hyaline, veins all dark, costal cell grayish, second submarginal cell about three times as long as apical width, second vein ending at about two-thirds the second submarginal cell, the first vein ending opposite its base, last two sections of third vein proportioned 3 : 2, the anterior branch ending at wing-tip, last two sections of fourth vein 1 : 9; stalk and base of knob of halteres yellow, the remainder blackish.

Holotype.—Mountain Home, California, in the foothills of the San Bernardino Mountains, 21 September, 1944.

Apolysis disjuncta, n. sp.

Male.—Length 1.4 mm. Body and legs wholly black, shining but not glistening; knob of halteres white. Frontal triangle black, face with a full row of six hairs, continuing on the cheeks, occiput almost bare; basal joints of antennae equal and globular, third joint elliptical, 2.5 times as long as deep, with preapical notch and microscopic thorn; proboscis about equal to head-height, straight, porrect and thick, palpi about one-fourth the proboscis. Hairs rather numerous at sides of thorax, of holotype black (pale in specimens from Cajon Pass). Vestiture of abdomen moderately sparse, of nearly uniform length; pygidium with a pair of elongate triangular ventral valves. Hairs of legs sparse, but those of femora and the extensor ones of hind tibiae longer than the width of their joints. Wings hyaline, the marginal cell grayish, veins blackish to root of wing, basal cells coextensive, second submarginal cell subequal to its petiole or slightly shorter, third vein ending beyond wing-tip, anal petiole longer than anterior crossvein, ambient vein complete, thin but distinct.

Female.—Front square, with a transverse indentation at middle, occipital weals undeveloped; incisures of segments three, four and five very narrowly whitish; hairs of body sparse and pale.

Holotype and allotype.—Sheep Creek Canyon, about four miles south of Phelan, San Barnardino County, California, 24 May, 1945. *Paratypes.*—One male taken with the types, two males from Cajon, California, 28 June, 1945, and two females from the eastern end of Barton Flats, San Bernardino Mountains, California, 16 June, 1945. The species name refers to the occasional presence of the posterior crossvein.

In addition to the type species, which classify as truly belonging to *Apolysis*, there are four specimens taken with the others that are puzzling. A male from Barton Flats and a female from Sheep Creek Canyon have the discal cell complete in the right wing but open in the left, and a male and a female from Sheep Creek Canyon have the discal cell complete in both wings, just as in *Oligodranes*. I conclude that these are aberrant specimens showing reversions to the ancestral neuration, a condition which could be possible in a nepionic genus.

Apolysis druias, n. sp.

Figure 13

Male.—Length 2 mm. Opaque black, the front edge of thorax ornate with white-cinereous dense coating, venter and pleurae dull cinereous, legs wholly black; pile long and white, except on back of head. Ocellar triangle black, front and face silvery white, occiput flattened, black, its hairs black; third antennal joint elliptical or elongate pyriform, 2.5 to 3 times as long as deep, the notch and thorn distinct; proboscis 1.25 times the head-height, slight curving toward tip, palpi one-fifth as long as proboscis, black. Front edge of thorax broadly cinereous, extending widely on sides to root of wing and following up transverse suture almost to a bifid median cinereous vitta, which may be confluent in front with the shoulder pattern, or may be set off by thin incursions of the black of the disk. Tergites of abdomen laterally with indication of cinereous tone, sternites with incisures narrowly yellow; pygidium pear-shaped in profile, base with an uncinate process on each side. Wings hyaline, veins blackish to base, sections of third vein proportioned 6 : 5 or subequal, the anterior branch ending at tip of wing, petiole of anal cell longer than anterior crossvein; root of halteres black, knob whitish.

Female.—All hairs white and short. Head, pleurae and venter densely cinereous, mesonotum maculate, tergites strikingly fasciate. Vertex and upper occiput sometimes brownish; front 1.3 times as long as width at antennae, narrowed behind, with scattered porrect hairs; occiput somewhat convex, the weals distinct and meeting below. Mesonotum tricolored, the front edge, sides and two anterior vittae light cinereous, a long narrow median stripe, two prominent sublateral spots and a smaller supra-alar spot black or blackish, the posterior portion, scutellum and forward extensions bounding the cinereous vittae olivaceous brown.

Types.—Thirty-five males and twenty-three females, collected from the small white flowers of a *Phacelia* at Oak Grove on the north side

of Palomar Mountain, San Diego County, California, 8 May, 1945; a male and a female from Oak Glen, 2 July, 1945; and three males and five females from the same white *Phacelia* at Verdemont, 24 May, 1945 and 25 April, 1946, the last two localities in San Bernardino County, California. The species name is selected in commemoration of the Druids who also frequented oak groves.

In the Citrus Experiment Station are three males and four females, collected by Professor P. H. Timberlake, at Riverside, California, 2 to 10 May, 1937, and at Warner Hot Springs, California, 9 May, 1936. The flies were taken from flowers of *Cryptantha intermedia* and *Eriophyllum confertiflorum*.

Apolysis glauca, n. sp.

Female.—Length 3 mm. Ground color black, thickly covered with light gray pollen. Vertex and occiput pilose with short white hairs, longer below, face with a row of short white hairs; antennae cinereous, basal joints equal, shorter than wide, the third joint slightly more than twice the basals, deepest at two-thirds and three times as long as deep, style distinct, inserted at upper apex of the third joint; proboscis twice as long as head-height, palpi one-fifth as long as proboscis. Thorax with an indication of a pair of darker median vittae, disappearing posteriorly, dorsum nearly bare, the hairs very short, white, most evident about humeri, notopleural region and apex of scutellum. Abdominal incisures very narrowly white, segments two to six on each side with a sublateral black oval spot, sternites with corresponding but smaller spots; hairs of abdomen short and white, more noticeable than on thorax. Legs lightly cinereous, black except the tip of femora and extreme base of tibiae, which are yellowish; hairs very short, pale, abundant but not conspicuous. Wings hyaline, whitish at base, veins largely pale yellow at base, distally brownish, stigma filling marginal cell, yellowish, first basal cell noticeably longer than second, sections of third vein equal, the anterior branch ending at wing-tip, section of fourth vein 1 : 7, petiole of anal cell fully half the length of the cubital vein closing the cell; halteres and alulae white.

Holotype.—Magnesium Springs Canyon, about half way between Palm Springs and Indio, California, 5 April, 1945.

Apolysis minutissima, n. sp.

Male.—Length 0.75 mm. Shining black, with halteres yellowish white, practically devoid of hair. Upper facets coarse, occupying about two-thirds of the eye, the lower facets contrastingly minute; basal joints of antennae minute, third joint broadly elliptical, about three times as long as the basal two and twice as long as wide; proboscis shorter than head-height, palpi not visible. Thoracic hairs scattering and short, but arranged in three longitudinal rows on back; scutellum prominent, almost hemispherical, with four small pale hairs. Tibiae and tarsi fuscous. Wings hyaline, stigma very weak, veins delicate, scarcely paler at base, ambient vein very thin beyond wing-tip, sections of fourth vein proportioned about 1 : 10, petiole of anal cell one-third the length of the cubital vein closing the cell.

Holotype.—29 Palms, California, 28 August, 1934 (P. H. Timberlake). This species is so different from *A. timberlakei*, which was taken at the same time, that it is probable they are distinct, instead of representing the two sexes of extreme dimorphism.

Apolysis mohavea, n. sp.

Female.—Length 1.8 mm. Head and thorax cinereous, abdomen yellowish. Sides of face fringed with short hairs; first antennal joint minute, second globular, third twice the length of the basals combined, broadly elliptical, plainly notched above the apex, scarcely twice as long as deep; proboscis one and one-half times the head-height, palpi thin, one-third the length of the proboscis. Dorsum of thorax almost bare, the sparse dorsocentrals and acrostichal hairs minute, scutellum with six minute hairs. Femora cinereous, anterior tibiae yellowish, all tarsi black. Wings hyaline, veins of basal half pale yellowish, stigma very weak, yellowish, second submarginal cell three times as long as wide, the first vein ending opposite its beginning, the second vein before its middle, sections of fourth vein proportioned 1 : 8; halteres yellowish white.

Holotype.—On desert flowers, base of Piute Butte, Mojave Desert, California, 12 May, 1944. *Paratype.*—One female, same locality, 24 April, 1946.

Apolysis petiolata, n. sp.

Male.—Length 1.4 mm. Body shining black over all, the knob of the halteres white, third antennal joint opaque. Face with two microscopic hairs under the antennae; occipital hairs extremely sparse and short; upper facets moderate; antennae with first joint shorter than the globular second, third joint one and two-thirds the length of the basal two, bluntly elliptical, twice as long as deep; proboscis but slightly longer than head-height, straight and slender, palpi one-fourth as long as the proboscis. Mesonotum glabrous except for a few pale hairs above the notopleural suture, scutellum bearing four minute hairs. Each of the last three abdominal segments with a sparse transverse row of minute hairs. Legs with microscopic hairs, only subshining. Wings hyaline, costa vanishing beyond the wing-tip, veins delicate, basal and posterior veins almost uncolored, stigma very weak, sections of fourth vein proportioned 1 : 7; petiole of anal cell about half the length of the cubital vein closing the cell.

Female.—Differs in the longer second marginal cell as indicated in the key, veins black to root of wing, sections of fourth vein about 1 : 8.

Holotype.—Swept from desert flowers at the base of Piute Butte, Mojave Desert, California, 12 May, 1944. The species is remarkable in the long petiole of the second submarginal cell of the male. *Allotype* female: Magnesium Springs Canyon, near Indio, California, 5 April, 1945. *Paratypes.*—One female, same locality as allotype, 4 April, 1946; one female, Andreas Canyon, near Palm Springs, California, 15 May, 1932, collected by P. H. Timberlake on *Eriodictyon crassifolium* (C. E. S.).

Apolysis timberlakei, n. sp.

Female.—Length 1.3 mm. Head and thorax cinereous, almost silvery pruinose, bare. Basal joints of antennae very small, cinereous, third joint nearly twice the length of the basals combined, bluntly elliptical, about twice as long as deep; proboscis twice the head-height, palpi one-fourth the length of the proboscis. Abdomen pale yellow. Femora cinereous, anterior tibiae and metatarsi yellowish brown. Wings hyaline, veins on basal half pale yellowish, second submarginal cell three times as long as wide, the first vein ending opposite its base, the second vein at the middle of the cell, sections of fourth vein proportioned 1 : 9; halteres pale yellowish white.

Holotype.—29 Palms, California, 28 August, 1934 (P. H. Timberlake).

A female from Palm Springs, 18 November, 1943, is apparently the same species, but its proboscis and palpi are shorter, and the tarsi are darker. It measures 1.65 mm.

KEY TO THE AMERICAN SPECIES OF OLIGODRANES

1. First antennal joint about three times as long as second, provided with hairs above and below; occiput of female with very strong vertical weals on each side of neck; robust, mostly shining; abdomen of male opaque; pilose, male with abundant black pile on propleura and usually on face and occiput; abdomen with yellow fasciae; proboscis strongly arched; posterior crossvein of male rather straight but oblique to fifth vein, of female sinuous; 5 mm. (*cinctura*) 2

   First antennal joint never more than twice as long as second, never provided with hair below and rarely above; occipital weals and central groove less pronounced, or undeveloped 3

2. Second submarginal cell at least three times as long as apical width, anterior branch of third vein ending at wing-tip; female typically with three broad thinly cinereous notal vittae. (Cal., Wash., Ida.), **cinctura** Coquillett

   Second submarginal cell scarcely twice as long as wide, the anterior branch of third vein sinuously curving forward to end much before wing-tip; disc of notum of both sexes uniformly shining. (Cal., Wash.), **setosus** Cresson

3. Posterior crossvein more or less sinuous and oblique 4

   Posterior crossvein straight or very slightly arched and about at right angles to third and fourth veins 8

4. Face pilose; anterior crossvein nearly at or beyond middle of discal cell; thorax and abdomen opaque densely cinereous in part; proboscis long and curved. (If mesonotum of male is black with pronounced cinereous shoulder triangles, see *lasius*, couplet **33**; if body is very pilose and wholly cinereous, see *comosus*, couplet 15.) 5

   Face bare below antennae, sometimes with hairs near cheeks; anterior crossvein normally near basal third of discal cell; proboscis 1.5 to 2 times head-height 6

5. Mesonotum densely and uniformly cinereous except for four small glistening black spots transversely placed near suture; abdomen cinereous, hind margins of segments showing yellowish-white ground-color; knees testaceous; 4.75 mm. (Cal.) ..... **speculifer**

   Male: the cinereous mesonotum with four heavy opaque black vittae; base of abdominal segments black. Female: vittae less intense and the black fasciae narrow; legs black. (Cal., Ariz., N. Mex., Tex.) .. **trochilus** Coquillett

6. Palpi about half as long as proboscis; no sagittal brown line between the median vittae of female 7

   Palpi about one-sixth the length of proboscis; notum of male black with dull cinereous markings at shoulders, sides and a prescutellar pair; female notum with five brown vittae; front of female brown longer than wide, of male satiny brown; 3 mm. (Cal.) ..... **montanus**

7. Hairs sparse and white; notum of male brown, of female centrally brown and anteriorly bivittate; abdomen cinereous with base of segments darker; 6 mm. (Cal.) (*capax* Coquillett.) (If front part of mesonotum is heavily cinereous pruinose, see *togatus*, couplet 36).....**mus** Bigot

Hairs of occiput and thorax of male abundant, long and dark, of female sparse and pale; dorsum of thorax and abdomen of male deep velvet black, usually with two triangular dark cinereous marks on front edge of thorax; notum and abdomen of female brownish black, usually with shoulders and scutellum cinereous, sometimes with incisures yellow; 3–5 mm. (Cal., Oreg., Wash., Ida., Mont., Ala., Fla., N. Car., Md.), **sigma** Coquillett

8. Third antennal joint broadest before middle and slightly tapering to the blunt apex; tibiae largely yellow; front and face of male silvery. (If tergites have paired jet-black spots, see *maculatus*, couplet 66; if notum has a broad intensely black median vitta, see *distinctus*, at 27)..... 9

Third antennal joint in profile broadest at or beyond middle, at least not uniformly tapering from near base.....10

9. Male: white pilose; proboscis three times head-height; genitalia reddish, the yellow abdominal fasciae narrow; notum with two median black vittae and two broad lateral marks; 3.75 mm. (Baja Cal.)..**albopilosus** Cole

Pile sparse; proboscis not much longer than head-height; abdomen with whitish fasciae, venter white; notum centrally brown continued in front as two median lines; 2.5–4 mm. (Cal.).....**fasciola** Coquillett

10. Males: eyes broadly contiguous along the front.....11

Females: eyes widely separated.....54

11. Thorax and abdomen wholly shining black, at most faintly pruinose below; palpi more than half as long as proboscis; third antennal joint one-half longer than deep; halteres white; 1.6 mm. (Ariz.) (If palpi are small and third antennal joint is longer, see *Apolysis disjuncta*).....**ater** Cresson

Body more or less opaque, abdomen never polished jet black.....12

12. Front and upper part of face wholly silvery white when viewed from above.....13

Front and face more or less golden, brown, blackish, or at most gray pollinose.....45

13. Mesonotum uniformly and closely cinereous, of various shades of gray but without dark pattern, at most with extremely faint indications of vittae...14

Mesonotum black or the disk variously marked with dark pattern.....21

14. Head, thorax and abdomen white-pilose, scutellum with retrorse hairs; abdomen cinereous; anterior crossvein at two-fifths to middle of discal cell, basal half of costa yellowish, apical half blackish.....15

Not closely pilose, hairs shorter and more sparse, femora never pilose beneath; abdomen not strongly fasciate; costa not bicolored.....17

15. Proboscis four times head-height and strongly curved; body with dense and very long pile; abdomen wholly cinereous; legs wholly black; 3 mm. (Cal.).....**comosus**

Proboscis not over twice the head-height; pile only moderately abundant; knees yellowish.....16

16. Abdomen with very narrow yellow incisures; notal hairs on dorsocentral and acrostichal rows, bare between, femora with long hairs beneath; palpi one-third length of proboscis; third antennal joint about twice as long as deep; 2.5 mm. (Cal.).....**acrostichalis**

Abdomen with strong yellow fasciae; notal hairs uniformly scattered, femora with short hairs beneath; palpi very short; third antennal joint about four times as long as deep; claws and pulvilli large; 6 mm. (Cal.), **retrorsus**

17. Venter mostly yellow, tergites not or but thinly cinereous; anterior crossvein near base of discal cell.....18

Venter and dorsum of abdomen similar, black in ground color.....19

18. Tibiae and base of tarsi yellowish; notum and scutellum gray; tergites usually brown, sometimes yellow at base of abdomen, and with paler but not contrasting incisures; second submarginal cell nearly as long as petiole;[2] apical thorn of antennae minute or invisible; proboscis nearly

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[2]The petiole is that part of the third vein between the anterior crossvein and the fork.

twice head-height; 1.5 mm. (Cal.) ..... **bicolor**

Legs black; notum and scutellum brownish black, tergites black, the incisures contrasting yellow; second submarginal cell distinctly shorter than petiole; antennal thorn distinct; proboscis only slightly longer than head-height; 1.8 mm. (Cal.) ..... **dissimilis**

19. Abdominal segments strongly cinereous with narrow yellow incisures, first segment usually more or less yellowish 20

Abdomen wholly black, thinly cinereous, incisures not differentiated; mesonotum with two faint vittae; anterior crossvein at two-fifths the discal cell; 2.75 mm. (Cal.) ..... **instabilis**

20. Mesonotum uniformly cinereous; anterior crossvein near middle of discal cell; proboscis less than twice head-height; 1.35 mm. (Cal.) ..... **cinereus**

Mesonotum with two faint vittae; anterior crossvein near two-fifths the discal cell; proboscis more than twice head-height; 2.1 mm. (Cal., Ariz.) ..... **polius**

21. Tergites with or without cinereous fasciae, but not with distinct yellow bands though the incisures may be very narrowly yellow; legs black, at most the knees narrowly reddish 22

Tergites banded with distinct yellow fasciae on hind margins of segments ... 41

22. Mesonotum primarily vittate; abdominal incisures very narrowly grayish or yellowish; palpi and legs black; face bare, cheeks with scattered short hairs 23

Mesonotum not definitely vittate; sides of face usually and the cheeks and occiput white-pilose 27

23. Median dark vitta divided full-length by a cinereous stripe, not reaching scutellum; proboscis not much longer than head, palpi half the length of proboscis; 2–3 mm. (Cal.) (If proboscis is nearly four times head-length, see *longirostris*, couplet 53) ..... **divisus**

Median dark vitta divided only in front, usually an attenuated projection to scutellum; proboscis much longer than head-height, palpi relatively shorter 24

24. Inner edge of the cinereous shoulder marks extending beyond transverse suture, each of the two median dark vittae narrower than the enclosed sagittal cinereous spot; abdomen more or less cinereous 25

Disk of mesonotum almost all covered with the blackish pattern, each of the two median dark vittae wider than the enclosed sagittal cinereous triangle; tergites subshining black; veins blackish to base; 1.5 mm. (Cal.) ..... **dolorosus**

25. Anterior crossvein near basal third of the relatively small discal cell, sections of fifth vein equal; proboscis less than twice head-height; halteres white. (If proboscis is more than three times head-height, see *longirostris*, couplet 53) 26

Anterior crossvein near basal fourth of discal cell, last section of fifth vein shorter than preceding; proboscis two to three times head-height, thin and straight, palpi about one-fourth as long as proboscis; halteres usually with blackish tip; veins pale at base; 2 mm. (Cal.) ..... **pulcher**

26. General color of mesonotum black, the posterior expansions of the cinereous shoulder marks not encroaching on transverse suture; legs wholly black; palpi nearly half as long as proboscis; veins black; 1.5 mm. (Cf. couplet 35.) (Cal.) ..... **scapularis**

General color of mesonotum brown, the extensions of the cinereous shoulder marks laterally filling the transverse suture; knees narrowly yellowish; palpi about one-fifth the proboscis; veins pale at base; 1.5 to 2.5 mm. (Cal.) ..... **panneus**

27. Mesonotum densely white-pollinose, marked with a wide median opaque black stripe and large double sublateral spots; 3.5 mm. (Cal.) .... **distinctus**

Mesonotum densely cinereous pollinose, marked on each side with two sublateral rounded brown spots; anterior crossvein near base of discal cell; 2.7 mm. (Cal.) ..... **neuter**

Disk of mesonotum black or blackish, usually the anterior edge with light-colored pollinose markings 28

28. Proboscis three to four times head-height, very thin, curved, palpi linear, one-sixth as long as proboscis 29

Proboscis shorter, usually thicker, nearly straight, palpi relatively longer; discal cell moderate, last section of fifth vein usually at least half as long as preceding section....30

29. Third antennal joint narrow, not notched; discal cell moderate, sections of fifth vein subequal, anterior crossvein at basal third of discal cell; front and sides of mesonotum coated with cinereous pollen merging into the brownish black disk; 2.4 mm. (See couplet 42.) (Cal.).....**eremitis**

Third antennal joint with preapical notch; discal cell long, sections of fifth vein 3 : 1, anterior crossvein near basal fourth of discal cell; front of mesonotum with three sharply limited whitish triangles, disk opaque black; abdomen not banded; 3 mm. (Cal.) (If notal marks are vague and dark brownish, see *pullatus*, couplet 40).....**sipho**

30. Front part of mesonotum variously marked with white-cinereous pattern...31

Front part of mesonotum with no white-cinereous marks, though sometimes the pollen less intensely black.....39

31. Front part of mesonotum with two separated white-cinereous marks, the sagittal area between them black like the disk.....32

Front part of mesonotum with white-cinereous pollen on the sagittal portion contiguous or not with the shoulder spots; palpi black.....34

32. Palpi yellow except tip; proboscis twice head-height; the two cinereous marks of notum triangular and confluent with the cinereous humeri; abdomen with cinereous fasciae; veins yellowish at base, last section of fifth vein at least half as long as the preceding; second submarginal cell equal to petiole or longer.....33

Palpi black; proboscis equal to head-height; the two cinereous marks of notum rounded and separated from the cinereous humeri; veins blackish at base, last section of fifth vein less than half the preceding, second submarginal cell shorter than its petiole; 2.8 mm. (Cal.) (If shoulder marks are triangular, see *scapulatus*, couplet 38).....**bifarius**

33. Third antennal joint widest at middle; knobs of halteres largely black; abdomen fasciate with wide black and narrower cinereous bands; veins firm and blackish; 4 mm. (Cal.).....**lasius**

Third antennal joint widest beyond middle; knobs of halteres yellow; abdomen largely cinereous; veins pale toward base; 3 mm. (Cal.)....**colei**

34. Inner edge of shoulder marks extending to or beyond transverse suture; halteres white; veins more or less blackish at base.....35

Cinereous pattern of front edge of notum not nearly reaching transverse suture.....36

35. Face bare; markings of thorax rather dull cinereous; 1.5 mm. (Cal.)..**scapularis**

Sides of face bearded almost to antennae; markings of thorax almost silvery white; 2.8 mm. (Cal.).....**loricatus**

36. Abdomen opaque black, at most cinereous on lateral angles; veins black to base; halteres more or less black.....37

Abdominal segments broadly cinereous posteriorly; veins yellowish at base; halteres white; notum glaucous; 3 mm. (Cal.).....**togatus**

37. Fare bare; hairs of head, body and legs short; third antennal joint slender, three times as long as deep, broadest beyond middle; 2.2 mm. (Cal.), **bilineatus**

Face bearded; head, thorax and abdomen pilose; third antennal joint wide, twice as long as deep, broadest at middle, with strong thorn.....38

38. Third vein forked before end of first vein, costal ratio of marginal and submarginal cells 1 : 1.25 : 1; femora with few hairs; 2.5 mm. (Cal.), **scapulatus**

Third vein forked beyond end of first vein, costal ratio 1 : 2 : 1; femora pilose; 3 mm. (Cal.).....**trifidus**

39. Face strongly bearded; mesonotal suture marked with two cinereous spots on disk, ground color of body steely blue-black; sternites cinereous, margined with yellow; palpi half as long as proboscis; anterior crossvein near middle of discal cell, second submarginal cell longer than petiole; 3.6 mm. (Oreg.).....**chalybeus**

Upper part of face bare; ground color of body black; palpi one-fourth as long as proboscis; second submarginal cell shorter than its petiole; anterior crossvein near basal third of discal cell.....40

40. Last section of fifth vein one-third the preceding; mesonotum with front,

sides and large supra-alar spot dark cinereous; sternites cinereous, with yellow incisures; halteres blackish above; 2.3 mm. (Cal.) ..... **pullatus**

Sections of fifth vein equal; thorax and body wholly black; halteres white; 1.25 mm. (N. Mex.) ..... **cockerelli**

41. Anterior part of mesonotum densely cinereous and narrowly bivittate with brown. (If anterior part is golden cinereous and proboscis is nearly four times head-height, see *longirostris*, couplet 53) 42

Anterior part of mesonotum not bivittate with brown 43

42. Mesonotum cinereous with faint sublateral presutural spot; only knees yellow; palpi one-fourth the length of proboscis, black; 3 to 3.5 mm. (Tex.) ..... **bivittatus** Cresson

Disk of mesonotum almost wholly brown behind suture; tibiae and tarsi more or less fuscous; palpi one-eighth the proboscis, yellowish; proboscis three times head-height; 2.4 mm. (See couplet 29.) (Cal.) ..... **eremitis**

43. Mesonotum blackish, with faint darker sublateral presutural spot; venter fasciate; pile long on head and abdomen; 3 mm. (N. Mex.) ... **knabi** Cresson

Mesonotum bivittate with cinereous at least in front, the middle brown stripe attenuated anteriorly, the sublateral brown stripes expanded behind suture; venter yellow; nearly bare species. (If mesonotum is almost uniformly dark and face has hairs, see *bicolor*, couplets 18 and 50) ... 44

44. The two cinereous vittae completely separating the distinct middle stripe from the sublateral large brown areas; second submarginal cell enclosing wing-tip; 1.75 mm. (Ariz.) ..... **parkeri**

The three vague brown vittae confluent on disk of thorax; anterior branch of third vein ending at wing-tip; 2 mm. (Cf. couplet 49.) (Cal.) **anthonomus**

45. Pile mostly blackish; wings sometimes slightly brownish 46

Pile or sparse hairs white or pale, except sometimes on scutellum; wings hyaline or nearly so 48

46. Mesonotum and abdomen opaque or subopaque black; legs black; sections of fifth vein nearly equal; 1.65 mm 47

Mesonotum densely yellowish-gray pollinose, with a pair of slender vittae and three sublateral black spots; abdomen grayish yellow; legs largely yellow; 5 mm. (Mex.) ..... **trochilides** Williston

47. Second submarginal cell shorter than petiole; face bare; second anal vein merely a fold in wing-membrane. (Cal., Oreg., Wash.) ..... **palpalis**

Second submarginal cell equal to petiole; face bearing long though sparse hairs; base of second anal vein chitinized. (Cal.) ..... **analis**

48. Knees and more or less of tibiae and tarsi yellowish 49

Legs wholly black 51

49. Notum evittate; sections of fifth vein equal 50

Notum vaguely trivittate with brown; last section of fifth vein shorter; proboscis slightly curving down; 2 mm. (Cf. couplet 44.) (Cal.) .. **anthonomus**

50. Proboscis straight; pollen of thorax brown; second submarginal cell opening beyond tip of wing; 1.3 to 2 mm. (N. Mex., Cal.) ..... **marginalis** Cresson

Proboscis curving slightly down; pollen of thorax gray; second submarginal cell filling wing-tip; 1.5 mm. (Cal.) ..... **bicolor**

51. Mesonotum and abdomen almost wholly black; halteres usually black or blackish; second submarginal cell shorter than petiole; proboscis as long as head-height, palpi two-thirds the proboscis; 2.4 mm. (Cal.) (If proboscis is twice head-height and palpi are one-fifth proboscis, see *pullatus*, couplet 40) ..... **lugens**

Mesonotum and abdomen not wholly matte black 52

52. Mesonotum with broad median and sublateral black vittae; abdomen with yellow fasciae; 3 to 3.8 mm. (N. Mex.) ..... **mitis** Cresson

Mesonotal markings narrow or weak; yellow abdominal fasciae rather narrow 53

53. Mesonotum broadly trivittate with brown, but the markings faint or even absent; head entirely black; second submarginal cell three times as long as wide; 1.6 to 2 mm. (N. Mex., Tex.) ..... **obscurus** Cresson

Mesonotum and scutellum golden brown pollinose, narrowly bivittate in front and with one or two presutural and one postsutural round deep brown spots; front and face pale golden; second submarginal cell four times as long as wide; 2.6 mm. (Cal.) (If scutellum and rear of mesonotum are cinereous pollinose, see *pulcher*, couplet 25) ..... **longirostris**

FEMALES

54. Body opaque or subopaque black; legs wholly black, at most knees pale; second submarginal cell ending symmetrically at wing-tip. (Cf. also the dull form of *obscurus* Cresson, couplet 74).....55
Body variously colored but not uniformly opaque or subopaque black.....58
55. Second submarginal cell shorter than petiole, second anal vein only a fold in the wing-membrane.....56
Second submarginal cell subequal to petiole, second anal vein chitinized at base; hairs of occiput and thorax black, of face and cheeks pale; 1.65 mm. (Cal.).....**analis**
56. Proboscis less than twice head-height, palpi half as long as proboscis; legs all black.....57
Proboscis more than twice head-height, palpi one-sixth as long as proboscis; front oblong and cinereous; knees yellowish; 1.35 mm. (N. Mex.)..**cockerelli**
57. Nearly bare, but all hairs and bristles pale; front a little longer than wide; 2.4 mm. (Cal.).....**lugens**
Nearly bare, but hairs and bristles all black; front square; 1.65 mm. (Cal., Oreg., Wash.).....**palpalis**
58. Scutellum, humeri, anterior half of front and first antennal joint yellow; 3 mm.....59
Scutellum and at least most of the other parts black in ground color, with more or less dense cinereous coating.....60
59. Palpi black; ground color of prothorax black; tibiae apically dark; pubescence of upper side golden. (Cal.).....**togatus**
Palpi yellow at base; prothorax yellow; all tibiae yellow. (N. Mex.), **knabi** Cresson
60. Mesonotum distinctly trivittate with brown or black, i.e., the median dorsocentral dark vittae confluent, not divided by a middle line of lighter colored pollen, the sublateral vittae more or less interrupted at suture.....61
Mesonotum otherwise marked or evittate, but not with an undivided median dark vitta.....65
61. Palpi black, about one-third or one-fourth head-height; legs all black; venter more or less fuscous; ground color of head black.....62
Palpi very short; at least knees yellowish.....63
62. Tergites opaque black with white fasciae; thoracic vittae separated by more or less distinct cinereous interspaces except in front, the supra-alar spot somewhat isolated; proboscis about three times head-height; 2 mm. (Cal.) (If vittae and fasciae are very weak, see *obscurus*, couplet 74).....**pulcher**
Tergites subshining black, with yellow fasciae; thoracic vittae vaguely separated, confluent with the supra-alar spot; proboscis about twice head-height; 1.5 mm. (Cal.).....**dolorosus**
63. Wholly white-pollinose except for the contrasting opaque black color pattern; face and occiput white-pilose; 3.5 mm. (Cal.).....**distinctus**
Light-colored pollen cinereous, the dark pattern brown; venter yellow; nearly bare species.....64
64. Middle stripe of thorax broad; front and face with a broad black median stripe, orbits yellow; palpi yellow; legs largely yellow; 2 mm. (N. Mex.), **formosus** Cresson
Middle stripe of thorax narrow, almost pointed in front; orbits not differentiated; palpi black; only knees yellow; 2.5 mm. (Ariz.).....**parkeri**
65. The black and blackish bases of abdominal segments when viewed from behind more or less broadly interrupted medially.....66
If the bases of the abdominal segments are blackish the bands are complete..67
66. Thorax with five large jet black spots; abdominal marks black; proboscis over three times head-height, curved, palpi black; face cinereous, closely pilose; third antennal joint four times as long as deep; tibiae mostly yellow; branch of third vein arising abruptly; 4.2 mm. (Cal.)...**maculatus**
Thorax with four dark brown vittae, the interspaces cinereous; abdominal marks blackish; proboscis twice the head-height, palpi yellow except tip; face yellow, bare; third antennal joint rounded, less than three times as

long as deep; only knees yellowish; branch of third vein gently curving; 3 mm. (Cal.) (If posterior half of front and spaces between vittae are brown, see *lasius*, couplet 86; if thorax is evittate, see *eremitis*, couplet 76)..... **colei**

67. Legs including knees wholly black, sometimes the knees minutely reddish...68
Front tibiae more or less yellow, or at least knees distinctly yellowish.....85

68. Thoracic vittae almost or wholly wanting.....69
Thorax bivittate in front and with three or four sublateral dark spots; abdomen more or less fasciate.....75

69. Very pilose; anterior crossvein at middle of discal cell; front about twice as broad at antennae as at ocelli; white-cinereous species, basal half of costa yellow, distal half blackish; 3 to 6 mm. (Cal.)..... **comosus**
Nearly bare species; sides of front nearly parallel (*obscurus* unknown).....70

70. Thorax deep brown, with two prominent cinereous shoulder triangles; abdomen black, the incisures narrowly yellow; 2.5 mm. (Cal.).... **scapulatus**
Thorax cinereous or weakly vittate, but not with shoulder triangles.....71

71. Anterior crossvein at basal third or middle of discal cell, the first basal cell longer than the second; abdomen more or less fasciate.....72
Anterior crossvein near base of discal cell, the two basal cells nearly coextensive; abdominal fasciae almost wanting.....74

72. Abdomen largely or almost wholly yellow, venter all yellow; the cinereous coating of head and thorax with slight golden tone; first basal cell distinctly longer than second, the sections of fifth vein equal; 1.35 mm. (Cal.)..... **cinereus**
Abdomen mostly black, fasciae narrow, venter like dorsum; the cinereous coating of head and thorax whitish gray.....73

73. Anterior crossvein near middle of discal cell, the first basal cell distinctly longer than second, sections of fifth vein subequal; 2.5 mm. (Cal.).. **panneus**
Anterior crossvein nearer base of discal cell, the first basal cell longer than second by length of crossvein, last section of fifth vein shorter than preceding; 2.1 mm. (Cal., Ariz.)..... **polius**

74. The weak thoracic markings consisting of a broad median and two narrow stripes, or absent; head entirely black; 1.6 to 2 mm. (N. Mex., Tex.), **obscurus** Cresson
The thoracic pattern consisting of a divided brown median stripe and vague sublateral marks; front anteriorly cinereous, posteriorly brown, face cinereous, upper occiput brown; 2 to 3 mm. (Cal.)..... **divisus**

75. Facial orbits closely hairy, front cinereous and pubescent; third antennal joint nearly three times as long as deep; palpi half as long as proboscis; abdominal fasciae cinereous; 3 to 3.8 mm. (N. Mex.)..... **mitis** Cresson
Face nearly or completely bare, front more or less brownish and nearly bare; third antennal joint shorter; abdomen without complete cinereous fasciae.....76

76. Third antennal joint slender, three times as long as deep, not notched; proboscis more than three times head-height, slender, palpi one-sixth the proboscis; sides of thorax cinereous; 2.4 mm. (Cal.)..... **eremitis**
Third antennal joint shorter, with preapical notch.....77

77. Proboscis about four times head-height, palpi about one-sixth the proboscis; pollen of head and of thorax between the dark vittae golden brown.....78
Proboscis shorter, palpi relatively longer, usually about half the length of the proboscis; pollen at least of side margins of thorax cinereous.....80

78. Discal cell elongate, sections of fifth vein 3 : 1 to 2 : 1.....79
Discal cell normal, sections of fifth vein about 4 : 3; abdominal fasciae distinct, sides of abdomen black; 2.6 mm. (Cal.) (If thorax has a sagittal intervittal brown line, see *montanus*, couplet 6)..... **longirostris**

79. Sublateral vitta entire; second vein ending much nearer first than to branch of third vein; 3 mm. (Cal.)..... **sipho**
Sublateral vitta interrupted at transverse suture; second vein ending midway between first and branch of third; 2.3 mm. (Cal.)..... **pullatus**

80. Occiput and mesonotum frosted cinereous, vittae narrow and pale brown, a sagittal vitta projecting from scutellum between the normal middle pair; front frosted cinereous with a light brown spot before ocelli;

abdomen pubescent; third antennal joint less than twice as long as deep, deeply notched; 2.7 mm. (Cal.) ..... **neuter**

The pair of median vittae blackish or brown, no dark extra stripe on sagittal line between the vittae; nearly bare species; front largely or wholly brownish-pollinose; third antennal joint 2 to 2.5 times as long as deep 81

81. General color of abdomen deep black, without cinereous pollen, the incisures narrowly pale yellow; the two median black vittae linear; third antennal joint scarcely excised; proboscis short; 2.2 mm. (Cal.) ... **bilineatus**

General color of abdomen usually largely cinereous, at least on sides, the fasciae rarely contrasting; vittae not linear 82

82. Discal cell rather small, sections of fifth vein nearly equal, last section of fourth vein longer than preceding; general color of notal disk between vittae brownish cinereous; 1.5 mm ..... **scapularis**

Discal cell longer, the sections of fifth vein 2 : 1, last section of fourth vein not longer than preceding; general color of notal disk dark brown 83

83. Notal vittae and spots diffuse 84

Notal vittae and spots strong; 3 mm. (Cal.) ..... **trifidus**

84. Abdominal fasciae bright yellow, nearly one-fourth the segments; 2.8 mm. (Cal.) ..... **loricatus**

Abdominal fasciae sordid yellow, narrow; 2.8 mm. (Cal.) ..... **bifarius**

85. Thorax with two narrow dark median vittae in front and more or less distinct sublateral spots 86

Thoracic markings faint or wanting 87

86. Palpi black; notum largely cinereous, the lateral spots weak; abdominal fasciae yellow; 3.5 mm. (Tex.) ..... **bivittatus** Cresson

Palpi yellow except tip; mesonotum largely brown pollinose, the lateral spots strong; abdominal fasciae cinereous; 5 mm. (Cal.) (If vittae are bounded by cinereous pollen, see *Colei*, couplet 66) ..... **lasius**

87. Legs wholly or largely yellowish 88

Only knees yellow; pollen of body dense, golden-gray or cinereous 92

88. Abdomen wholly yellow; proboscis slightly curving down 89

Abdominal tergites black or blackish at base, fasciate with yellow 90

89. Proboscis less than twice head-height; head and thorax brownish; femora dusky near middle; 1.8 mm. (Cal.) ..... **dissimilis**

Proboscis more than twice head-height; head and thorax grayish; legs light yellow; 1.5 mm. (Cal.) ..... **bicolor**

90. Proboscis three times head-height, slightly curving down, palpi yellow; femora black except knees; third antennal joint slender, three times as long as deep, not notched; petiole of anal cell longer than anterior crossvein; 2.4 mm. (Cal.) (If palpi are black and petiole of anal cell is shorter than crossvein, see *retrorsus*, couplet 93; if incisures are narrowly white, see *polius*, couplet 92) ..... **eremitus**

Proboscis twice head-height or shorter, nearly straight; third antennal joint shorter 91

91. Femora mostly black; anterior crossvein near middle of discal cell, petiole of anal cell shorter than anterior crossvein; disk of scutellum with some retrorse pile; 2.4 mm. (Cal.) ..... **acrostichalis**

Femora mostly yellow; anterior crossvein near base of discal cell, petiole of anal cell longer than crossvein; disk of scutellum bare; 2 mm. (Cal., N. Mex.) ..... **marginalis** Cresson

92. Anterior crossvein near middle of discal cell 93

Anterior crossvein near base of discal cell; body black but heavily cinereous pollinose, abdominal segments narrowly white behind; 2.1 mm. (Cal., Ariz.) ..... **polius**

93. First antennal joint yellowish; discal cell large, last section of fifth vein only a little longer than posterior crossvein; palpi about one-eighth length of proboscis; yellow fasciae of abdomen wide; 5 mm. (Cal.) (If no yellow fasciae, see *Colei*, couplet 66) ..... **retrorsus**

Antennae black; discal cell moderate, the last section of fifth vein nearly twice length of posterior crossvein; palpi one-fourth as long as proboscis; 2.5 mm. (Cal.) ..... **acrostichalis** var. **matutinus**

Oligodranes acrostichalis, n. sp.

Male.—Length 2.4 mm. Whitish cinereous, heavily pollinose, with abundant long white pile. Ocellar triangle cinereous, frontal triangle nearly equilateral, extending halfway to ocellus, satiny white, face wider than combined length of basal antennal joints, above with satiny white triangle which appears dark when seen from front, sides loosely pilose almost to antennae, mouth-opening blackish, antennae black, cinereous, second joint globular, first joint shorter, third joint bluntly elliptical, widest at middle, scarcely notched above tip where there is a minute stubby black style; proboscis 1.5 times head-height, nearly straight, palpi black, slender but thickest at two-thirds. Thorax and abdomen wholly cinereous, scutellum with retrorse pile; abdominal incisures narrowly whitish. Legs black except knees, moderately cinereous, femora pilose beneath. Wings hyaline, veins yellowish, costa black beyond first vein, second submarginal cell about 3.5 times as long as wide, second vein ending before middle of second submarginal cell, sections of third vein 4 : 5, anterior branch ending at wing-tip, sections of fourth vein 2 : 3 : 5, of fifth vein 3 : 2, petiole of anal cell as long as anterior crossvein, ambient vein complete; halteres white.

Female.—Pile short. Thorax cinereous pollinose with slightly yellowish tinge. Front slightly narrowed posteriorly, nearly as wide at antennae as its length; occipital weals low-placed and strong, post-vertical grooves weak; proboscis thicker and quite straight, palpi longer. Basal two-thirds of tibiae and base of metatarsi yellowish. Ground color of abdomen almost wholly yellowish white, tergites 2 to 7 black at base though sides broadly yellow. Anterior crossvein at middle of discal cell.

Types.—Three males and four females collected at Palm Springs, California, 24 April, 1944, during the morning only, on flowers of Malacothrix.

Oligodranes acrostichalis, var. **matutinus,** n. var.

A female taken with the others is different from all the other species and is distinct enough to receive at least a varietal name. It is close to ***acrostichalis***, but has shorter and sparser hairs, front more brownish, proboscis thicker and slightly curved down, the palpi one-fourth the length of the proboscis, the basal two-thirds of abdominal tergites blackish beneath the cinereous pollen, venter with basal half of segments similarly dark; legs wholly black except the narrow knees; anal cell closed at margin, anterior crossvein just before middle of discal cell.

Holotype.—Palm Springs, California, 24 April, 1944. A female in the Citrus Experiment Station, taken by P. H. Timberlake at San Lucas, California, 20 August, 1935, on ***Eriogonum gracile***, has the yellow color more extended on knees and venter. ***Matutínus***, Latin, active during the morning hours, referring to its fondness for ***Malacothrix***, the flowers of which close in the afternoon.

Oligodranes analis, n. sp.

Male.—Length 1.65 mm. A sombre opaque black, black-pilose

species with black legs, blackish halteres and slightly infumated wings. Front hairy, face with long hairs to antennae; first joint of antennae slightly longer than second, hairy above, third joint oval, twice as long as deep, widest at middle, apically rounded, excavated above tip with stubby erect thorn; proboscis but little longer than head-height, straight, palpi nearly half as long as proboscis, thin. Disk of scutellum bare, margin with eight or ten strong hairs. Veins black to base, costal cell opaque; sections of third vein 1.2 : 1, the anterior branch ending at wing-tip, sections of fourth vein 1 : 4 : 5, fifth vein 4 : 3, anal petiole twice the length of anterior crossvein, ambient vein weak beyond anal vein; halteres yellowish to fuscous or even black, calypteres black.

Female.—Pollen of head and thorax with dark brown tinge; hairs shorter and sparse, those of face and cheeks pale; sides of front nearly parallel, occipital weals and grooves undeveloped; submarginal cell a little longer; knob of halteres yellow.

Holotype.—Near Hemet Lake, on the Southern base of Mount San Jacinto, California, 7 June, 1942; *allotype:* Ortega Highway, three miles due Southwest of Lake Elsinore, California, elevation 2600 ft., 26 May, 1944. *Paratypes:* Sixteen males and twenty-six females, all from Southern California, with types; from Oak Grove, 8 May, 1945; Sheep Creek Canyon near Phelan, 24 May, 1945; Cajon, 28 June, 1945; Mountain Home, 21 June, 1945; Barton Flats in San Bernardino Mountains, 16 June, 1945, on *Ceanothus.* A female from The Gavilan, Riverside County, 13 June, 1938, was taken by P. H. Timberlake on *Adenostemon fasciculatum.*

This is the only species having the second anal vein chitinized, which however becomes evanescent at about three-fourths its length. One of the females lacks the posterior crossvein of the left wing, a condition suggestive of the origin of *Apolysis* and *Empididеicus* from forms with complete neuration.

Oligodranes anthonomus, n. sp.

Male.—Length 2 mm. Face bare, occiput cinereous, hairs sparse, weals distinct, extending above neck; third antennal joint 2.75 times as long as deep, nearly oblong, obliquely truncate above tip and with thorn and setula; proboscis twice the head-height, slightly curving downward, palpi fuscous, thin, one-sixth the length of proboscis. Thoracic pattern not contrasting, front third of notum cinereous merging into the dark brown disk but leaving three brown linear vittae, posterior area and scutellum brownish cinereous and not vittate, lateral margin when viewed from side continuously cinereous, pleura cinereous. Abdomen black except first segment yellow, next three with yellowish white margins, segments 5 to 7 with narrow yellowish incisures, venter yellowish, lateral hairs white, radiating, the dorsal hairs shorter and reflexed. Legs black, knees yellowish. Wings clear hyaline, veins thin, fuscous, paler at base, first basal cell longer than second, sections of fourth vein 1 : 3 : 4, of fifth vein about 2 : 1, anal petiole longer than anterior crossvein; halteres whitish.

Female.—Front 1.7 times as long as width at ocellus, wider at antennae, brownish posteriorly merging to cinereous in front, center of

face obliterated by mouth; occipital weals distinct. Cinereous pollen of front half of mesonotum with yellowish tone, the darker vittae indistinct. Abdominal incisures, lateral margin and venter yellow. Apices of coxae, trochanters, base and apex of femora, anterior tibiae, base of anterior metatarsi and hind knees yellowish. Anterior crossvein at basal fourth of discal cell.

Holotype and allotype: About six miles Southwest of Adelanto, California, in the Mojave Desert, 23 May, 1945. The species name is from the Greek and means feeding on flowers.

Oligodranes bicolor, n. sp.

Male.—Length 1.5 mm. Nearly bare, occiput and thorax dark cinereous, humeri and posterior calli with yellow dot, a few marginal hairs on scutellum, abdomen fuscous, the first segment and incisures yellow, venter yellow except apex. Sides of face and cheeks as wide as a basal joint of antenna, with scattered short hairs almost to antennae; eyes contiguous three-fourths the distance between ocellus and antennae; proboscis scarcely twice as long as head-height, palpi very thin, one-fifth the length of the proboscis, dull yellowish; basal joints of antennae spherical, third joint oval, widest at middle, scarcely twice as long as deep, with an extremely minute point above apex. Legs blackish, knees, tibiae and base of tarsi yellowish. Wings hyaline, veins thin, dark except at base, last two sections of third vein subequal, second submarginal cell three times as long as wide, the anterior branch ending at wing-tip, sections of fourth vein 1 : 3 : 4, of fifth vein 4 : 3, anal petiole longer than anterior crossvein, ambient vein evanescent along posterior border; halteres whitish.

Female.—Head and thorax brownish cinereous, abdomen and legs including apex of coxae light yellowish, ends of tarsi darker. Sides of front nearly parallel, the width four-fifths the length; occipital weals moderate, postvertical grooves not developed.

Types collected from flowers, base of Piute Butte, in Western Mojave Desert, California, 12 May, 1944. Thirty-six male and seven female *paratopotypes*; six males and four females, Quail Springs and vicinity, 5 October, 1934, two females, Morongo, 28 September, 1944; one female, near Whitewater, 27 October, 1934, all in Southern California. The autumnal specimens, which are all from near the Little San Bernardino Mountains, differ from those from the Mojave Desert only in having the humeri somewhat more yellow and the abdomen of the male lighter in color.

In the Citrus Experiment Station there are four specimens collected by Professor Timberlake: a male from Mission Canyon, 1 October, 1932, on *Lepidospartum*, a male from Palm Springs, 28 March, 1936, on creosote bush; a female from Victorville, 28 October, 1934, on rabbit-brush, *Chrysothamnus*, a female from Whitewater, 27 October, 1934, on *Aplopappus acradenius*. Apparently the species is double-brooded.

Oligodranes bifarius, n. sp.

Male.—Length 2.8 mm. Closely related to *O. trifidus*, differing from its diagnosis thus: Proboscis usually shorter, oblique. White cinereous

pattern of thorax consisting only of two rounded spots on anterior edge separated from the cinereous humeri, the sides dull cinereous, the black forward extension of disk about as broad as the light colored spots. Lower part of pygidium with a finger-like extension near middle of inner edge. Alulae wholly white except the extreme black base.

Female.—The dark thoracic markings brown, not sharply differentiated. Rim of alulae white; knob of halteres white.

Types: Four males and six females, Sheep Creek Canyon, near Phelan, California, 24 May, 1945.

Two females in Citrus Experiment Station, collected by P. H. Timberlake: The Gavilan, Riverside County, 1 April, 1938, on *Plagiobothrys californicus*, and Big Bear Valley, California, 6 July, 1934, on *Apocynum androsaemifolium*. *Bifarius*, Lat., divided into two parts, referring to the double marks on front of thorax.

Oligodranes bilineatus, n. sp.

Male.—Length 2.2 mm. Sombre, opaque black, thinly pilose, the hairs all pale. Front and face satiny white, face bare; cheeks and occiput thinly cinereous, beard sparse and short; basal joints of antennae equal, third joint elongate pyriform, 2.5 times as long as deep, widest at three-fourths, the preapical notch and thorn minute; proboscis only slightly longer than head-height, palpi two-thirds the length of the proboscis, black, slender. Mesonotum with semicircular white-cinereous collar, which when viewed from above is divided into three parts by two black extensions of the disk, sides very lightly dark cinereous, encroaching along the suture, pleura dark cinereous, disk of scutellum bare, margin fringed with twenty hairs. Venter of abdomen somewhat cinereous, incisures yellowish. Legs all black, the femora not cinereous. Wings very slightly infumated, veins black to base, second submarginal cell encompassing tip of wing, three times as long as wide, sections of third vein 5 : 4, of fourth vein 1 : 3 : 4, of fifth vein 3 : 2, anal petiole longer than anterior crossvein, ambient vein complete but thin; halteres infuscated.

Female.—Head and thorax dull brownish black, slightly gray on lower occiput, behind humeri, on pleura and venter. Front parallel-sided, slightly longer than wide; occiput without weals or grooves. Notum marked with two well separated somewhat subshining black lines which reach from prothorax to midway between suture and scutellum, and with a sublateral vitta interrupted at suture, abbreviated in front but longer behind, the supra-alar spot weak. Abdomen pure black above, the margins of segments narrowly yellow.

Holotype and allotype: Big Bear Lake, San Bernardino County, California, 6 July, 1941. *Paratypes:* Another pair collected with the types, a male from Pinehurst, 7 June, 1935, two females from Oak Grove on the Northeast base of Mount Palomar, 8 May, 1945, and three females from Sheep Creek Canyon, San Bernardino County, 24 May, 1945, all in California.

Oligodranes chalybeus, n. sp.

Male.—Length 3.6 mm. Upper occiput black, lower cinereous and

with white beard, mouth-opening black, silvery part of face nearly horizontal and tapering into the orbits, lower face and cheeks white-cinereous with long white pile to the silvery section; eyes contiguous three-fourths the distance to antennae; antennae black, first joint a little longer than the globular second, third joint nearly twice as long as the basals together, widest at middle, slightly over twice as long as deep, blunt, with flattened emargination above tip bearing a minute stubby thorn; proboscis 1.5 times the head-height, nearly straight, palpi black, thin, half as long as proboscis. Mesonotum opaque black, in front with very faint indications of two abbreviated narrow brownish vittae, white pilose, especially behind humeri, mesopleura with long straggling hairs, pleura rather thinly cinereous. Scutellum and abdomen opaque black above, the last two segments, apical angles of tergites and venter cinereous. Legs wholly black, thinly cinereous, femoral hairs long. Wings hyaline, veins fuscous, paler at base, second submarginal cell proximally narrow, about four times as long as wide, sections of third vein proportioned 3 : 4, the anterior branch ending at wing-tip, fourth vein 5 : 6 : 10, fifth vein 3 : 2, anal petiole shorter than anterior cross-vein, ambient vein complete.

Holotype: Mount Hood, Oregon, at 3,000 feet, 29 July, 1921.

Oligodranes cinctura Coquillett and variety **setosa** Cresson

Figure 10

This species represents an extreme form of *Oligodranes*. Coquillett's original species has the thorax of the female trivittate with loose gray pollen and the beard of the male black. I have a pair from Magnesium Springs Canyon, near Cathedral City, California, in which the female agrees but the male has all the hairs of the head pure white excepting a few individual hairs on the lower occiput.

Cresson described *setosa* from a form with shining thorax in both sexes, black beard in male, and widely open second submarginal cell. I have a pair from Yakima, Washington, in which the male agrees but the female has the second submarginal cell narrow as usual.

The third antennal joint varies in length from two to three times as long as deep. Some females have the occipital weals excessively developed into outstanding welts. I have taken the *cinctura* form with pollinose thorax from Western Mojave Desert and Cathedral Canyon, California, and the *setosa* form with shining thorax from Pullman, Washington; Worley, Idaho; and Barton Flats in the San Bernardino Mountains, California. Professor Timberlake has collected *cinctura* on Mountain Home Creek in the San Bernardino Mountains on *Gilia*, and *setosa* on Herkey Creek in the San Jacinto Mountains, California, on *Gilia exilis*.

Oligodranes cinereus, n. sp.

Male.—Length 1.35 mm. Sparsely short-pilose. Frontal triangle and facial orbits satiny white, face with about five hairs, cheeks and occiput uniformly cinereous, postocellar grooves confluent just behind the ocellar triangle, weals reaching halfway along the occiput, mouth-opening black; eyes contiguous halfway to antennae; antennae black,

thinly cinereous, basal joints equal, third joint elliptical, slightly over twice as long as deep, excised above apex, with small thorn; proboscis less than twice head-height, nearly straight, palpi one-sixth as long as proboscis. Thorax uniformly cinereous, with no indications of vittae, scutellar disk with very few erect hairs. Abdomen definitely cinereous, not shining, incisures narrowly whitish, first segment usually more or less yellowish. Knees very narrowly slightly reddish. Wings hyaline, costal cell opalescent, veins mostly pale, first vein reaching apical third of costa, second vein curving forward at end, costal ratio between first and third veins 1 : 1 : 0.5, segments of fourth vein 1 : 1 : 3, of fifth vein subequal, anal petiole as long as anterior crossvein, ambient vein complete.

Holotype: Base of Piute Butte in Western Mojave Desert, California, 12 May, 1944. *Paratypes:* Three topotypic males, 24 April, 1946; one male, Palm Springs, California, 24 April, 1944; and two males, six miles East of Garnet, California, 4 April, 1945. A female from Verdemont, California, 23 April, 1946, has been included in the key as possibly this species.

This seems to be a reduced form of *acrostichalis*, distinguished from the other small species by the uniformly pure cinereous thorax.

Oligodranes cockerelli, n. sp.

Male.—Length 1.25 mm. Body including abdomen wholly black, nearly bare, the few hairs short and white. Proboscis 1.75 times the head-height, thick, palpi one-fourth as long as proboscis. Legs black, knees narrowly yellowish. Wings clear hyaline, veins blackish to base, basal cells of same length, second submarginal cell three-fourths as long as its petiole, the anterior branch of third vein ending just before wing-tip, sections of fourth vein proportioned 1 : 2.75 : 4, anal petiole slightly longer than anterior crossvein; knob of halteres white.

Female.—Proboscis thick, curving down, palpi thin and fuscous; the yellow of front knees more extended than in male.

Types.—A pair received from Professor T. D. A. Cockerell, who collected them on flowers of a *Fallugia*, seven miles East of Grants, New Mexico, 23 May, 1945.

I have the honor to dedicate this species to Professor Cockerell, who sent the specimens as being the smallest flies he had ever seen.

Oligodranes colei, n. sp.

Male.—Length 3 mm. Front and facial orbits glistening white, the front and first antennal joint above with a few short hairs, sides of face pilose quite to the antennae, wider than basal antennal joint, occiput cinereous, pilose, beard prominent, oral opening mostly black; antennae black, cinereous, basal joints equal, third joint but little longer than basal pair, elongate pyriform, about twice as long as deep, flattened but not excised above apex, the thorn and setule invisible; proboscis nearly twice head-height, nearly straight, palpi one-third as long as proboscis, slender, preapically spatulate, yellow, the tip blackish. Mesonotum loosely pilose, mostly opaque black, the two shoulder triangles white-cinereous, sides blending into cinereous, which extends

in along the transverse suture, pleura white-cinereous, mesopleura pilose, scutellum opaque black, nearly bare, the margin thinly cinereous with long pile. Abdomen pilose, black in ground color, the first segment and margins of the others cinereous, venter cinereous with hind margins yellow. Legs black, knees very narrowly reddish, pile long on coxae and underside of femora. Wings hyaline, veins thin, dark, yellowish at base, second submarginal cell as long as its pedicel, narrow at base, the anterior branch of third vein ending at wing-tip, sections of fifth vein 3 : 2, anterior crossvein at or near middle of discal cell, anal petiole shorter than anterior crossvein; ambient vein complete; halteres white.

Female.—Face, cheeks and anterior margin of front yellow, remainder of head strongly cinereous; basal antennal joints fuscous; front nearly square; moderate occipital weals on each side of neck, postvertical grooves very shallow. Mesonotum largely cinereous, quadrivittate with brown, the median vittae narrow, stopping much before the cinereous scutellum, the sublateral vittae broader, coextensive behind but shortened before suture, a small supra-alar spot, posterior hairs retrorse; pleura light cinereous, meso- and sternopleura hairy. Abdomen loosely hairy, largely cinereous, the bases of the second and following segments blackish, more or less interrupted medianly by the posterior cinereous borders (best seen from behind), ventral segments with yellow incisures, last segment yellow. Femora pubescent.

Holotype: Morongo, California, 28 September, 1944. *Allotype:* Quail Spring in the Joshua Tree National Monument, California, 5 October, 1934. *Paratypes:* One male and four females taken with the allotype.

The species is named in regard for my friend and colleague, Doctor Frank R. Cole, who was on the trip to Quail Springs when the specimens were taken.

Oligodranes comosus, n. sp.

Figure 3

Male.—Length 4.5 mm. Wholly and densely white-cinereous pollinose and abundantly clothed with long white pile. Front much wider than high, snowy white, sides of face wide and heavily bearded; basal joints of antennae cinereous, first joint twice as long as second, third joint elongate elliptical, 3.5 times as long as deep, the preapical notch and thorn small; proboscis strongly curved, five times head-height, palpi one-tenth as long as proboscis. Pro-, meso- and front half of sternopleura heavily pilose, scutellum with dense erect pile. The abundant hairs of abdomen twice as long as segments. Legs black, the yellow pulvilli long, claws yellow at base and about as long as last tarsal joint, femora pubescent, closely pilose below. Wings hyaline, veins blackish, basal half of costa and the two veins behind yellowish, veins pale at base, a patch of white hairs on base of costa, first basal cell longer than second by three times anterior crossvein, costal ratio between first and third veins 1.25 : 1 : 0.75, third vein forked before end of first vein, the branch arising in a gentle curve and ending at wing-tip, sections of fourth vein 1 : 0.9 : 1.25, of fifth vein 1.8 : 1, posterior crossvein slightly arcuate or sinuous, anal petiole as long as anterior crossvein, ambient vein complete; halteres yellowish, alulae white.

Female.—Length 3 to 6 mm. Densely pilose; occipital weals long, strong and nearly straight; front almost white, pubescent, as wide at antennae as long, tapering to half-width at ocelli; abdominal segments margined with yellow.

Type and allotype: About five miles East of Palm Springs, California, 17 April, 1937, collected by P. H. Timberlake on Indigobush, *Dalea Schottii* (Citrus Experiment Station collection). *Paratypes*: A male, Box Canyon, California, 4 April, 1937, on Desert poppy, *Eschscholtzia minutiflora* (Timberlake); a female, Palm Canyon of the Borego Desert, California, 29 March, 1936, on Creosotebush, *Larrea divaricata* (Timberlake); a female, Deep Creek, California, 16 May, 1927, on Deerweed, *Lotus scoparius* (Timberlake, CES); one male, three miles West of Palm Springs, California, 6 May, 1946, on Indigobush. *Comosus*, Latin, having abundant, long hair.

Oligodranes dissimilis, n. sp.

Male.—Length 1.8 mm. Nearly bare, head, thorax, upper side of abdomen and legs blackish in ground color, the upper occiput and thorax overlaid with fine dark brown pollen, becoming dull gray at neck and on lower occiput; abdomen opaque, the incisures narrowly but contrastingly yellow, first segment piceous, base of sternites slightly darkened. Frontal triangle silvery, wider than high, lower face and cheeks with a few straggling short hairs, sides of face as wide as basal antennal joint; eyes contiguous two-thirds the way to the antennae; basal joints of antennae equal, spherical, third joint slightly widest at middle, 2.5 times as long as deep, blunt, the preapical excavation distinct and bearing a sharp thorn and above it an evident though minute setule; proboscis 1.2 times the head-height, curving slightly, palpi one-third as long as proboscis, thin, fuscous. Wings hyaline, second vein ending beyond middle of second submarginal cell, sections of third vein proportioned 17 : 13, the anterior branch ending just before wing-tip, sections of fourth vein 1 : 4 : 5, of fifth vein 11 : 9, anal petiole as long as anterior crossvein; halteres yellowish white.

Female.—Pollen of head and thorax light brown and denser and almost cinereous on pleura and lower occiput; abdomen wholly yellow, but the sixth and seventh tergites darkened except sides and incisures (possibly individual discoloration); coxae apically, trochanters, ends of femora, tibiae except distal part of hind pair, yellow; sides of front nearly parallel, width of front at antennae four-fifths the length; occipital weals rather well developed, postvertical grooves very weak.

Types: Two specimens, Morongo, S. W. San Bernardino County, California, 26 September, 1944. Closely allied to *O. bicolor*. The male and female show great dimorphism.

Oligodranes distinctus, n. sp.

Male.—Length 3.5 mm. Heavily coated with white pollen except a V-shaped postocellar groove, the intense opaque black thoracic decorations, a triangular scutellar spot, a black band on base of second tergite and three small basal spots on third tergite. Pile long and white, dense on face, loose on notum and abdomen. Front much broader than

high, intensely white pruinose; occipital weals narrow, extending halfway up; basal joints of antennae equal, cinereous, third joint black, three times as long as deep, widest just before middle, blunt, scarcely excised, with microscopic terminal point and preapical setule; proboscis 2.5 times head-height, rigid, slightly curved, palpi one-twelfth as long as proboscis. Median stripe of notum wide, not reaching neck or scutellum, notched behind, presutural spot large and oval, narrowly separated at suture from the large U-shaped posterior mark; pleura heavily white-pollinose, mesopleura densely pilose; scutellar hairs long, sparse, erect. Incisures of tergites and sternites narrowly whitish but scarcely differentiated beneath the dense whitish coating; pygidium triangular, with two appressed ovoid cinereous large dorsal valves. Legs black, hairs of the cinereous femora equal to their diameter, knees very narrowly fuscous. Wings hyaline, veins dark apically and yellowish basally, third vein ratio 5 : 4, branched much before end of first vein, the fork widely curving and ending just before wing-tip, fourth vein 1 : 3 : 2.5, fifth vein 3 : 2, the last section as long as posterior crossvein, anal petiole equal to anterior crossvein, ambient vein abruptly stopping at anal vein; halteres and alulae white.

Female.—Pile shorter but equally dense; occipital weals extending two-thirds; palpi one-eighth the proboscis length; sublateral thoracic vitta smaller, the posterior section broken into two oval spots; tip of abdomen compressed, yellow.

Holotype and allotype: Verdemont, near San Bernardino, California, 1 May, 1946. *Paratypes:* A female taken with the types; one female from Southern base of Piute Butte in Western Mojave Desert, California, 12 May, 1944.

The species is easily recognized by its contrasting colors and the black color pattern of the thorax.

Oligodranes divisus, n. sp.

Male.—Length 2 mm. Cinereous, thorax quadrivittate, abdomen opaque blackish above, dark cinereous beneath. Front and upper face satiny white, remainder of face narrowly white pollinose, cheeks and occiput cinereous, postocellar grooves deep, no weals; eyes contiguous two-thirds the distance to antennae, ocellar triangle black; basal joints of antennae equal, third joint elliptical, widest at middle, 2.5 times as long as deep, preapical notch minute, thorn and setule microscopic. Thoracic vittae brownish black, the two middle vittae beginning just behind pronotum, narrow at first, stopping midway between suture and scutellum, the side vittae interrupted just behind suture, the anterior spot elliptical, the posterior tapering behind and evanescent just before scutellum, supra-alar spot rather small; broad front of the side margins, most of the posterior part, scutellum and pleura cinereous, mesopleura with a faint brown spot. Sternites with whitish margins, narrow on caudal segments. Legs not cinereous. Wings hyaline, veins thin, blackish, becoming fuscous at base, sections of third vein 5 : 4, of fourth vein 1 : 3 : 4, of fifth vein 5 : 4, anal petiole shorter than anterior crossvein, ambient vein evanescent on anal lobe; halteres white.

Female.—Thoracic pattern greatly weakened; front behind the

transverse depression, vertex and scutellum brownish; tergites cinereous on sides, more so on caudal segments. Front one-fourth longer than wide, parallel-sided; occipital vertical weals strong, postocellar V-grooves distinct.

Holotype and allotype: Magnesium Springs Canyon, midway between Palm Springs and Indio, California, 5 April, 1945.

A male measuring three millimeters, from Palm Springs, 24 April, 1944, differs in having the tergites laterally cinereous, with posterior margins noticeably yellow, and the discal cell somewhat longer. A female from the desert near Adelanto, California, 23 May, 1945, appears to belong to *divisus*, though its general color is more gray and the anterior crossvein is nearer the middle of the discal cell.

Oligodranes dolorosus, n. sp.

Male.—Length 1.5 to 2 mm. Hairs sparse and pale. Ocellar triangle black, front and upper face white pruinose, lower face white pollinose, upper occiput dark brown, lower part dark gray; basal joints of antennae equal, third joint obovate, twice as long as deep, the notch small, thorn minute. Mesonotum mostly occupied by the blackish brown pattern, leaving only the humeri, posthumeral triangles, a V-shaped notch at front of median vitta, sides and four vague spots on posterior portion brown-cinereous; the median vitta extending from pronotum to the dark brown scutellum and on the disk confluent with the large sublateral vitta which extends from humerus to posterior callus, the supra-alar spot not separate; pleura dark cinereous. Tergites with no cinereous pollen, quite shining, the yellow margins linear, venter lightly cinereous, the yellow margins narrow. Legs all black, femora not cinereous and without pile. Wings hyaline, second submarginal cell four times as long as wide, sections of third vein equal, the anterior branch ending at wing-tip, sections of fourth vein 1 : 4 : 5, of fifth vein 5 : 4; alulae whitish, halteres whitish with fuscous cap.

Female.—Front about one-fifth longer than wide, parallel-sided, brown pollinose behind, dark cinereous in front to the depression, face and narrow cheeks cinereous, upper occiput brownish, dark cinereous below, weals confined to lower occiput; proboscis slightly over twice the head-height, straight, palpi one-fourth as long as proboscis, thin. Thoracic pattern extensive, dark brown, the middle vitta beginning full width at the brownish pronotum and attaining scutellum as a narrowed stripe, the sublateral vitta broad, touching humeri, indented at suture and evanescent at posterior calli; the humeri, sides, four merging spots along hind margin, and scutellum dark cinereous; the intervittal lines brownish.

Types: Two males, seven females, from the Eastern part of Barton Flats, San Bernardino Mountains, California, elevation 6,250 feet, 3–21 September, 1944.

Oligodranes eremitis, n. sp.

Male.—Length 2.4 mm. Front and face snowy white, cheeks and occiput uniformly pure cinereous, face with a row of eight very short hairs almost to antennae, hairs of lower occiput short and scattered;

antennae black, thinly cinereous, basal joints equal, globular, third joint slender, rather oblong, parallel-sided, three times as long as deep, scarcely excavated at tip, the thorn and setule microscopic; proboscis slender, nearly straight, three times head-height; palpi very thin, yellow, about one-eighth as long as proboscis. Thorax nearly bare, cinereous in front of suture except for two narrow brownish vittae and a faint presutural spot, disk light brown, in the middle meeting the suture, on the sides and above the posterior calli cinereous; pleura cinereous, scutellum brown except extreme angles. Abdomen with short scattered hairs, viewed from front blackish with moderately broad light yellow margins on segments, viewed from back largely cinereous with brownish dorsal spots and pale margins, venter cinereous with narrow pale yellow interstices. Femora blackish, lightly cinereous, knees, tibiae and all of tarsi fuscous. Wings hyaline, veins thin, fuscous, paler basally, third vein ratio about 1 : 2 : 2, the anterior branch ending at wing-tip, fourth vein 1 : 2.7 : 3, fifth vein 2 : 1, anal petiole longer than anterior cross-vein; halteres whitish.

Female.—Front uniformly cinereous, nearly as wide as long, slightly narrowed posteriorly, occipital weals long and strong, upper grooves shallow, oral opening yellow in middle. Thorax all cinereous, not vittate but with a change in shade of the pollen where the anterior vittae and discal spot of the male are located, scutellum cinereous. Abdomen cinereous, first segment and apical and side margins of others widely pale yellow, with only faintest indication of the dark basal spots which give the impression when viewed from certain angles of being subinterrupted medianly. Tarsi and apex of tibiae blackish. Veins mostly yellow.

Type and allotype: Yucca Valley, San Bernardino County, California, 5 October, 1934. *Paratypes:* Two males from near Adelanto, California, 23 May, 1945; one male and two females from near Phelan, California, 28 June, 1945; three males, Piute Butte, Western Mojave Desert, California, 24 April, 1946. The paratypes have darker legs than the types. A female from Cathedral Canyon, near Palm Springs, California, 2 April, 1945, has shorter third antennal joint and may represent a closely related species. *Eremitis*, a desert inhabitant.

Oligodranes instabilis, n. sp.

Male.—Length 2.75 mm. Close to *O. cinereus*, differing from the description of the male as follows: Postocellar grooves separate until near neck, the weals reaching two-thirds the way up; eyes contiguous two-thirds the distance to the antennae, ocellar triangle black, antennae black; proboscis twice the head-height, palpi one-sixth as long as proboscis. Thorax only moderately cinereous, with faint indications of two dark gray median vittae. Abdomen thinly cinereous, subshining, wholly black including incisures. First vein reaching apical fourth of wing, second vein gently curved at end, third vein ratio 3 : 2 (in one specimen 3 : 1), costal ratio between first and third veins usually 1 : 1.3 : 1.

Female.—Front slightly brownish, one-half longer than width at ocellus; mesonotum cinereous with very faint brownish tone on disk;

abdomen varying from almost wholly honey-yellow to piceous with wide yellow incisures.

Types: Seventy-two specimens taken on flowers of *Geraea canescens*, near Truckhaven, midway the West side of Salton Sea, California, 3 April, 1946. Of these 13 are normal males with closed discal cell; 59 are females of which 41 are normal, 3 have the discal cell open in the left wing, and 8 in the right wing, and 7 open in both wings as in *Apolysis*. Sometimes the branch of the third vein is disconnected and some specimens have extra crossveins near the anterior crossvein. This fluctuation in the venation has suggested the species name, *instabilis*, Latin, inconstant.

Oligodranes lasius, n. sp.

Figure 9

Male.—Length 4 mm. Ground color black, pile long abundant and white. Front with parted silvery white hairs, face pilose almost to antennae, occiput cinereous, darker above, whitish pollinose below, heavily pilose; basal joints of antennae cinereous, the first joint one-half longer than the quadrate second and furnished with short silvery white hairs above, third joint rather oblong, one-half longer than the two basals and about three times as long as deep, emarginate above apex, no visible style; proboscis 2.5 times head-height, nearly straight, palpi slender, about one-fourth as long as proboscis. Shoulder triangles of white-cinereous pollen large, pointed behind, the mesial sides parallel and clearly delimited; pile moderately sparse on disk of notum but bunched on pro- and mesopleura and above notopleural suture, scutellar pile retrorse. Abdomen densely cinereous, base of segments black, venter cinereous. Legs more or less cinereous becoming darker distally, black with tips of femora yellowish, coxae and femora white-pilose. Wings glassy hyaline, veins fuscous at base and piceous apically, sections of third vein equal, the anterior branch ending at wing-tip, fourth vein ratio 2 : 3 : 4, fifth vein 2 : 1, posterior crossvein straight or very slightly sigmoid, sometimes with a short spur at middle, petiole of anal cell shorter than anterior crossvein, ambient vein complete; knob of halteres blackish except at base.

Female.—Hairs of body greatly reduced, face bare. Upper occiput and posterior two-thirds of front golden brown, anterior third of front golden cinereous, face and cheeks yellow, occipital weals not developed but postocellar triangular grooves strong. Disk of thorax rich brown becoming cinereous on humeri, sides, rear and scutellum, with two dark brown strong median vittae on anterior half, with broad sublateral vittae notched at suture and with a round supra-alar spot.

Types: Eleven males and four females, from the East end of Barton Flats, about 6300 feet elevation, San Bernardino Mountains, California, 1 to 12 September, 1944. One of the females has a remarkable deformity of the antennae. The right antenna has only the two basal joints which are a little subnormal in size. The left antenna has a lengthened first joint, a somewhat swollen and irregular second joint, the upper outer corner of which bears the transferred third joint of the right antenna, but it is broadly rounded and shorter than wide. From the end of the

second joint arises the greatly shortened and broadened third joint which is pyriform in shape and only one-half longer than deep. One of the males has the anal cell widely open. A headless male from Blewett Pass, Washington, 28 June, 1924, appears to be very close to this species. *Lasius*, from Greek, shaggy with hair.

Ologodranes longirostris, n. sp.

Figure 2

Male.—Length 2.6 mm. Front and upper face usually light golden, sometimes silvery, sides of face bare, cheeks with straggling hairs, occiput brown gray pruinose, weals strong and restricted to lower half, hairs short, sparse and growing up; third joint of antennae 2.5 times as long as deep, the notch short and deep, thorn strong; proboscis slender, curving, three or four times the head-height, palpi slender, about one-eighth as long as proboscis. General color of mesonotum light golden brown before suture and rich brown behind, the two vittae weak and narrow in front, strong and almost black behind suture, stopping at presutural area, in addition to the widely interrupted dark brown sublateral vitta a posthumeral brownish mark and a round supra-alar spot, the posterior sublateral mark more or less continued to corner of scutellum; pleura cinereous with light brownish tone, sternopleura with few small hairs. Abdomen brownish black, the light yellow fasciae of segments two to four about one-fifth the segment, of posterior segments very narrow, the fasciae not sharply limited anteriorly; upper edge of lower pygidium with broad inflexed lobe. All hairs of legs short. Wings hyaline, veins fuscous, paler at base, costal ratio of first to third veins 1 : 2 : 1, anterior branch ending at wing-tip, sections of fourth vein 1 : 2 : 3, of fifth vein subequal, first vein ending opposite basal fourth of second submarginal cell; rim of allulae white, halteres yellowish, slightly infuscated above.

Female.—Head golden brown, front nearly square, occipital weals strong, placed low, curving around and meeting below neck, post-ocellar grooves weak. Thoracic pattern much like that of male, the general light brown color of intervittae extending to prothorax, the pair of median vittae not attenuated anteriorly.

Types: Six males and thirty-four females, collected at the East end of Barton Flats, San Bernardino Mountains, California, elevation about 6400 feet, 31 July, 1942, and 3 to 21 September, 1944.

Oligodranes loricatus, n. sp.

Figure 6

Male.—Length 2.8 mm. Very close to *O. bifarius* and *trifidus*, agreeing with the description of the latter except as follows: Third antennal joint short and broad, obpyriform, scarcely twice as long as deep, widest beyond middle. The white cinereous pattern of mesonotum continuous across front and meeting the cinereous sides, with backward directed prongs on the dorsocentral lines to the transverse suture. The black pattern of the disk includes a posthumeral round spot formed by the cinereous transverse suture and the extension of the shoulder mark and a large mesial fork, the tines of which are faintly indicated

under the thick coating of white pollen. Upper edge of lower pygidium with a broadly rounded lobe occupying more than one-third the length. Sections of fourth vein proportioned 1 : 4 : 4, anal petiole not longer than anterior crossvein; allulae and rim white, knob of halteres white.

Female.—Entire front light brownish cinereous, occipital weals strong, extending halfway; palpi about one-third as long as proboscis. The pair of median vittae, the double sublateral and single small supra-alar spots seal brown, merging into the light brown-cinereous interspaces. Tergites cinereous only at posterior angles. Rim of alulae white; knob of halteres white.

Holotype: Male, collected in Sheep Creek Canyon on the Northeast base of Mount San Antonio, California, 24 May, 1945. *Allotype:* collected near Camp Baldy, on the South slope of the same mountain, 1 July, 1945. *Paratypes:* five males taken with the holotype; a male and two females taken with the allotype; a male from the East part of Barton Flat, 18 June, 1945; and a female from Mountain Home Creek, 4 July, 1938, on *Phacelia distans* (Timberlake), the last two localities in the San Bernardino Mountains, California.

There is some variation in the white cinereous pattern of the thorax of the male, an extreme specimen has a sagittal stripe extending to center of disk, with the long tines of the mesial fork showing black. *Loricatus*, Latin, clothed in mail.

Oligodranes lugens, n. sp.

Male.—Length 2.4 mm. An opaque black species without ornamentation. Face wholly bare, its sides parallel, brownish, beard of cheeks short and scant; eyes contiguous for three-fourths the frontal length; basal joints of antennae equal, third joint elongate pyriform, nearly three times as long as deep, the preapical notch deep, thorn distinct. Thorax with three vague brownish spots on collar, brown-pilose behind humeri. Legs without cinereous cast. Wings slightly infumated, veins black to base, second submarginal cell opening at tip of wing, sections of third vein 3 : 2, of fourth vein 1 : 3 : 3, of fifth vein about 2 : 1, anal petiole longer than anterior crossvein, ambient vein very weak; halteres and alulae black.

Female.—Nearly bare, the scattered hairs and bristles pale; wholly black, the knob of halteres pale yellow. Front parallel-sided, about one-sixth longer than wide, back of head smooth, without weals or grooves.

Holotype and allotype: Collected on the Ortega Highway, Southwest of Lake Elsinore, California, 29 June, 1942. *Paratypes:* Seven additional males taken with the types; two males, Sheep Creek Canyon, near Phelan, California, 24 May, 1945. *Lugens*, Latin, wearing mourning apparel.

Oligodranes maculatus, n. sp.

Figure 1

Female.—Length 4.2 mm. Head and body heavily white-cinereous pollinose, abdomen strongly fasciate with yellow; thorax marked with velvet-black spots as follows: a pair of large round presutural spots, a

large supra-alar spot shaped like a thick inverted J, a large obcordate prescutellar spot, a lunate mark at base of scutellum; second abdominal segment velvet-black except margins and a cinereous dot in middle, segments three and four except wide cinereous sides and a cinereous interruption at middle, segments five and six each with a pair of smaller sublateral black spots. Front about as wide as an eye, tapering behind, 1.5 times as long as width at antennae, face with close white beard, occiput densely white-pilose, weals large and strong; antennae black, lightly cinereous, the first joint twice as long as second and with a few hairs above, third joint strap-like, scarcely tapering, four times as long as deep, the preapical thorn and sulcus small; proboscis four times head-height, palpi one-seventh as long as proboscis. Pile of thorax moderate, pleura heavily pollinose, only the mesopleura pilose, scutellar disk with erect hairs. Venter heavily cinereous, the yellow fasciae broad. Coxae cinereous and pilose, femora hairy, blackish, the knees yellow, tibiae yellow with apical fourth blackish, tarsi blackish, the basal half of middle metatarsi yellowish. Wings hyaline, veins light fuscous, costal ratio between first and third veins 1 : 1.2 : 1.2, third vein forked before end of first vein, second submarginal cell wider than marginal, ratio of fourth vein 1 : 3 : 3, the fifth vein 4 : 3, anal petiole equal to anterior crossvein, ambient vein stopping at fifth vein; alulae and halteres white.

Holotype: Palm Canyon, at Palm Springs, California, 3 April, 1925, on *Encelia*, collected by Professor P. H. Timberlake for the Citrus Experiment Station.

This is the most distinctively marked species of the genus.

Oligodranes montanus, n. sp.

Male.—Length 3 mm. Front satiny brown, face bare, cheeks with few hairs, mouth opening glistening black, occipital hairs scattered and rather short; eyes contiguous two-thirds the frontal length; first antennal joint smaller than second, third joint obovate, wide, twice as long as deep, preapical notch deep, with distinct thorn and setule; proboscis 2.5 times head-height, slender, nearly straight, palpi slender, one-seventh as long as proboscis. Disk of thorax blackish, with two median black vittae and sublateral black vitta interrupted into two round spots, also a smaller black supra-alar spot, shoulders broadly cinereous confluent with the wide gray sides, posterior portion of notum less definitely marked with four brownish cinereous rounded spots, a pair before scutellum and one before each callus; pleura dark cinereous, scutellum black, the disk with scattered hairs. Abdomen black, subshining. Legs wholly black. Wings with slight yellowish tinge due to microtrichiae, first basal cell longer than second by more than the length of the anterior crossvein, costal ratio between first and third veins 1 : 1.5 : 0.9, third vein ratio 5 : 4, the branch ending just beyond wing-tip, ratio of fourth vein 1 : 3.5 : 3, of fifth vein 2 : 1, anal petiole equal to anterior crossvein, ambient vein thin but complete; alulae white, knob of halteres yellow.

Female.—Upper part of head brownish cinereous, front one-fourth longer than wide, parallel-sided, weals strong. Mesonotum largely

cinereous, marked with brown on a pair of narrow median vittae with an included sagittal vitta reaching the scutellum, and a broader interrupted sublateral vitta and small round supra-alar spot, scutellum cinereous. Abdomen blackish, with distinct yellow incisures.

Types: Two males and six females, collected by Professor P. H. Timberlake at Mill Creek, San Bernardino Mountains, California, at 6000 ft. elevation, 20 June, 1937, on *Penstemon Grinnelli*; types in Citrus Experiment Station.

Oligodranes neuter, n. sp.

Male.—Length 2.7 mm. Black, rather thinly coated with dark cinereous but denser and lighter on anterior half of thorax; loosely pilose. Front reaching thirdway between antennae and ocellus, viewed from below the face and front lose their white satiny sheen and appear black, ocellar triangle and mouth opening black; basal joints of antennae globular, the first slightly smaller, lightly cinereous, third joint twice as long as basal two, and twice as long as deep, widest at three-fourths, apex oblique with definite preapical blunt thorn; proboscis thin, twice the head-height, slightly curved, palpi one-fourth as long as proboscis, thin, black. Disk of thorax centrally and sublaterally subshining black, a rounded presutural sublateral opaque black spot, a pair of oval cinereous spots before scutellum, scutellum thinly cinereous, its disk almost bare. Abdomen black, thinly cinereous, no fasciae. Legs all black, pulvilli sordid white, the hairs under the femora equal in length to their diameter. Wings hyaline, veins thin, dark, slightly paler but not yellowish at base, second vein ending opposite middle of second submarginal cell, sections of third vein proportioned 3 : 2, the anterior branch ending at wing-tip, of fourth vein 1 : 4 : 4.5, of fifth vein 5 : 4, anal petiole equal to anterior crossvein, ambient vein thin; halteres white.

Female.—More heavily pollinose, nowhere subshining, fully as pilose the thoracic marks brown, consisting of two narrow anterior vittae, a median narrow posterior vitta, a presutural, a postsutural, and a supra-alar oval spot, scutellum cinereous; abdomen black, side angles widely cinereous, incisures yellow, first segment cinereous, venter cinereous with yellow incisures. Front parallel-sided, with square brown spot before ocellus, occipital weals low-placed and rather weak, postvertical grooves shallow; palpi nearly half the length of proboscis; third antennal joint broadly oval, the preapical excision deep, the thorn erect and curved, the adjacent style minute.

Type and allotype: Joshua Tree National Monument, San Bernardino County, California, 21 April, 1944. *Paratype:* A female, Morongo Valley, San Bernardino County, California, 20 April, 1944. *Neuter*, Latin, neither the one nor the other.

Oligodranes palpalis, n. sp.

Male.—Length 1.65 mm. Very similar to *O. analis*, but with reduced hairs, face bare, frontal triangle of male and first antennal joint with only a few microscopic hairs, very few hairs behind humeri; no chitinization of anal vein. Proboscis longer than head, palpi nearly as long as head-height, very slender. Second submarginal cell narrow, sections of

third vein 1 : 0.6, of fourth vein 1 : 2 : 4, of fifth vein 5 : 4, anal petiole equal to anterior crossvein; apical part of knob of halteres luteous.

Female.—Nearly bare, front square, occipital weals and grooves undeveloped. Scutellum with about ten rather stiff black marginal hairs. Ventral segments brown with narrow yellow margins.

Holotype and allotype: Blewett Pass, Chelan County, Washington, 17 July, 1920. *Paratypes:* Two topotypic females; two females from Mount Hood, Oregon, 29 July, 1921; one male, Logan Falls, Glacier Park, Montana, 14 July, 1935, and one male from Lake MacDonald, 13 July, 1935; a pair from Sheep Creek Canyon, San Bernardino County, California, 24 May, 1945, the female having the sides of the mesonotum dark cinereous instead of opaque black.

Oligodranes panneus, n. sp.

Male.—Length 2.5 mm. Face with two hairs near middle, occiput cinereous, weals strong and extending halfway, hairs sparse, postocellar grooves forming a deep V; eyes contiguous halfway to antennae, ocellar triangle cinereous; basal joints of antennae equal, third joint oblong, nearly three times as long as deep, preapical sulcus very small; proboscis twice head-height or less, nearly straight, palpi one-fifth as long as proboscis. General color of thorax dark brown, the anterior fourth cinereous continued posteriorly to prescutellar area as two dorsocentral stripes which follow the transverse suture to the grayish sides and thus enclose a pair of presutural rectangular brown marks, the median brown stripe continued forward to the pronotum as two thin vittae through the cinereous part and back to enclose a small narrow cinereous mark in front of scutellum; pleura dark cinereous, mesopleura with only about five small hairs. Abdomen dark brown, the venter and apical segments lightly cinereous, incisures not differentiated but the posterior half of tergites may be cinereous. Legs blackish, nearly bare, knees very narrowly testaceous. Wings slightly flavescent, veins fuscous to base, first basal cell longer than second by more than length of anterior crossvein, costal ratio between first and third veins 1 : 1.5 : 1, second submarginal cell subequal to its petiole, sections of fifth vein subequal, anterior crossvein, at two-fifths the discal cell, ambient vein complete; alulae white, knob of halteres yellow.

Female.—Dull brownish cinereous. Front uniformly yellowish cinereous, slightly longer than width at antennae, cheeks as wide as basal antennal joints. Notum with two narrow faintly brownish median vittae. Abdomen more densely cinereous than male, with distinct yellow fasciae. Costal ratio of marginal and submarginal cells 1 : 1.3 : 1.

Types: Five males and one female, two miles South of Travertine Rock on West side of Salton Sea, California, 29 May, 1936, on flowers of mesquite, collected by P. H. Timberlake and F. R. Platt. Types in collection of Citrus Experiment Station. *Panneus,* Latin, ragged, referring to the irregular edge of the shoulder stripes.

Oligodranes parkeri, n. sp.

Male.—Length 1.75 mm. General body color dark brown, pollen brownish cinereous on pleura and between the chocolate brown notal

pattern, humeri yellowish. Front and face whitish, sides of face as wide as basal antennal joints, bare, cheeks with scattered small hairs, occiput flat; basal joints of antennae equal, globular, third joint twice as long as basals and 2.5 times as long as deep, broadest at three-fourths, blunt, tipped with a small thorn and microscopic preapical setule, the emargination very small; proboscis twice head-height, nearly straight, palpi minute, thin, blackish. Scutellum brown, margined with subcinereous. Abdomen not cinereous, base of segments dull black, first segment and apical third of others yellowish. Legs blackish, the knees a little paler. Wings hyaline, veins thin, dark to base, first submarginal cell narrow, 3.5 times as long as wide, opening at wing-tip, third vein ratio 3 : 2, fourth vein 1 : 3 : 4, the last two sections slightly sigmoid, the first posterior cell about twice as wide on the margin as the second posterior, petiole of anal cell twice as long as anterior crossvein, ambient vein very thin beyond fourth vein; halteres yellowish white.

Female.—Length 2.5 mm. Front brownish cinereous, slightly longer than width at antennae, narrowed behind, center of mouth opening black, occipital weals strong, postocellar grooves distinct; proboscis slightly curving down. The dark gray of scutellum encroaching more on the brown pattern than in male. Anterior crossvein at basal fifth of discal cell and about equal to anal petiole; knob of halteres somewhat brownish in front.

Holotype: A male from Globe, Arizona, 21 April, 1938, collected by F. H. Parker. *Allotype* and a female *paratype* from San Carlos, Arizona, 30 April, 1938, also taken by Mr. Parker. Types in Melander Collection.

This species is readily recognized by the inverse arrangement of the notal vittae. The other species with bivittate thorax have the center stripe paler than the adjacent vittae. In *Parkeri* the central stripe is brown and the adjacent vittae are cinereous. The species is named for its discoverer, Frank H. Parker, in recognition of his enthusiasm as a student of Arizona insects and of his care in collecting and mounting the Bombyliidae.

Oligodranes polius, n. sp.

Female.—Length 2.1 mm. Heavily whitish-blue cinereous, head with faint brown tint above, mesonotal disk posteriorly with similar brownish median spot reaching on to scutellum and on each side with short similar postsutural sublateral vitta, also two faint indications of the presutural median vittae. Front nearly parallel-sided, face with full row of about seven hairs, cheeks narrower than basal antennal joints, occipital weals long and strong, postvertical grooves weak, mouth opening black; antennae cinereous, basal joints subequal, above with a few microscopic hairs, third joint oblong, twice as long as basals, three times as long as deep, apically scarcely excavated, the style microscopic and directed forward; proboscis three times head-height, slender, curving slightly down, palpi one-eighth as long as proboscis, black. Thorax nearly bare, scutellar disk bare, apical fringe short. Abdomen white pubescent, cinereous black, first segment and incisures whitish. Legs not pilose, cinereous black, knees narrowly and base of anterior tibiae reddish. Wings whitish hyaline, veins whitish at base

and piceous beyond furcations, costal cell opalescent, first basal cell longer than second by length of anterior crossvein, costal ratio of marginal and submarginal cells 1 : 1.5 : 1, second vein ending opposite middle of second submarginal cell, ratio of third vein 5 : 4, the anterior branch ending at wing-tip, fourth vein 1 : 2.5 : 3, fifth vein 3 : 2, anal petiole longer than anterior crossvein, ambient vein stopping at fourth vein, alulae and calypteres white.

Holotype: Palm Springs, California, 4 April, 1945. *Paratypes:* two females, Aquila, Arizona, 12 May, 1942. *Polius*, Greek, whitish gray.

A male collected in Magnesium Springs Canyon, eleven miles East of Palm Springs, 4 April, 1946, appears to belong to this species and has been included in the key as such. It differs from the females in lacking the postsutural median faint infuscation, the two faint median vittae being continued to the prescutellar area and separated by cinereous pollen; cheeks as wide as basal antennal joints, eyes contiguous halfway to antenna. Legs black. Anterior crossvein nearer middle of discal cell, the ratio of fourth vein 1 : 1.2 : 3.2, sections of third and fifth veins subequal.

Oligodranes pulcher, n. sp.

Figure 5

Male.—Length 2 mm. Black, largely cinereous with characteristic black thoracic markings; sparsely white-pilose. Front and facial orbits silvery white, remainder of face narrowly white with polished black oral margin, ocellar triangle black; eyes contiguous two-thirds the way to the antennae; basal joints of antennae equal, third joint elongate pyriform, twice as long as deep, widest beyond middle, the preapical emargination very small, thorn minute; proboscis slender, nearly straight, palpi linear. Thorax light cinereous on front, sides extending up the suture, scutellum, four more or less confluent spots on hind margin, two vittae, a deep anterior notch on the black central stripe, and the pleura; otherwise the notum is black, i.e., a strong median vitta widely notched in front and linear behind, and an irregular sublateral vitta notched at suture and confluent with the usual supra-alar spot; scutellum with a few erect hairs, a small bunch of hairs behind humeri. Base of tergites black, sides and margins cinereous, when viewed from back the incisures appear narrowly white, venter cinereous, the hind margins of the segments weakly pale. Legs without pile. Wings hyaline, veins thin, black, fuscous at extreme base, costal ratio of marginal and first submarginal cells 1 : 1.2, third vein ratio 4 : 3, the branch ending just before wing-tip, fourth vein 1 : 2.75 : 3, fifth vein 3 : 2, anal petiole equal to anterior crossvein, ambient vein very weak; knob of halteres white, often with blackish tip.

Female.—Pubescence sparse, face bare. Median vitta of thorax not notched in front but spreading toward humeri, the bounding cinereous stripes swerving toward humeri, somewhat duller than in male, sublateral vitta indented or broken at suture the posterior part quite reaching scutellum; abdomen blacker than thorax, opaque, venter lightly cinereous. Front slightly longer than wide, brown, a brown V-shaped mark on occiput behind ocelli, weals distinct.

Holotype and allotype: Palm Springs, California, 24 April, 1944. *Paratypes:* Seven males and twenty-five females taken with the types; one male, Morongo Valley, 19 April, 1944; five males and one female, Pala, 6 June, 1945; two males and four females, Oak Grove, 8 May, 1945; one female, Northwest Borego Desert, 3 May, 1945; four males, Verdemont, near San Bernardino, 1 May, 1946 and another, 13 May, 1946, all in California.

Oligodranes pullatus, n. sp.

Male.—Length 2.3 mm. Face with few hairs, occiput loosely pilose, weals strong, on lower half, postvertical notch deep; third joint of antennae curved above, 2.25 times as long as deep, the notch and thorn strong; proboscis twice head-height, slender, slightly curving down, palpi slender, one-fourth as long as proboscis. Pleura cinereous. Sides of abdomen thinly cinereous, venter cinereous, dorsal incisures linear, hairs long and scattered. Legs wholly black, with cinereous coating, femoral hairs sparse. Wings hyaline, first basal cell distinctly longer than second, second submarginal cell at tip of wing, four times as long as broad, sections of fourth vein proportioned 1 : 2.5 : 2.5, anal petiole twice as long as anterior crossvein, no ambient vein.

Female.—Front one-fourth longer than wide, nearly parallel-sided, sides of face bare, occipital weals strong, extending up two-thirds, postvertical grooves weak; third antennal joint shorter and thicker than in male; proboscis about three times head-height, palpi one-sixth the proboscis length. Notum mostly brownish, the double median dark brown vittae divided by a paler brown sagittal stripe and stopping on the grayish prescutellar area. Abdomen black, the distinct incisures pale yellow, base of sternites black and slightly cinereous.

Holotype and allotype: Cajon, California, in the pass between the San Gabriel and San Bernardino Mountains, 28 June, 1945. *Paratypes:* One female, Sheep Creek Canyon in Western San Bernardino County, California, 24 May, 1945; two males and twelve females, Mountain Home Canyon, San Bernardino Mountains, California, 21 June, 1945, on flowers of the Yerba Santa, *Eriodictyon trichocalyx*, the males having the frontal triangle golden. *Pullatus*, Latin, wearing black clothes.

Oligodranes retrorsus, n. sp.

Figure 12

Male.—Length 6 mm. Heavily encrusted with white pollen, densely white-pilose, no vittae but abdomen strongly fasciate. Ocellar triangle cinereous, front and larger part of face glistening silvery white, which appears ivory white when seen from front, face as broad as half the length of the third antennal joint, closely bearded quite to antennae, mouth opening black; eyes contiguous halfway; basal joints of antennae short cylindrical, equal, third joint elongate, four times as long as deep, widest at middle and then tapering, truncate at tip and with terminal minute thorn and setule, with fuscous annulus at base; proboscis one-half longer than head-height, stout, straight, porrect, palpi less than one-eighth the length of the proboscis, black, with a few white hairs. Legs cinereous, knees yellow, coxae and outer sides of femora pilose, claws and pulvilli nearly as long as last tarsal joint. Wings hyaline,

base of the bicolored costa with golden fringe, veins yellow, apically dark, sections of third vein equal, branch arising steeply and ending at wing-tip, anterior crossvein at or just before middle of discal cell, anal petiole very short, ambient vein complete; alulae white, halteres yellow.

Female.—Head small, proboscis twice the head-height or longer, body pubescent rather than pilose, the hairs longest on lower occiput, face with scattering hairs. Front broad, as wide at antennae as length, golden pollinose, occipital weals distinct, postvertical grooves forming the upper part of a broad V. Pollen of notal disk slightly golden. Basal fourth or less of tibiae yellowish, claws and pulvilli normal. First abdominal segment yellow, sometimes more or less of base of abdomen yellowish.

Type and allotype: Near Whitewater, California, 27 October, 1934. *Paratypes:* Four males and two females taken with the types; seven females, Quail Spring in the Joshua Tree National Monument, California, 5 October, 1934; one female, Cabazon, California, 7 November, 1934; one female, Piute Butte, Mojave Desert, California, 24 April, 1946. On the same trip when the types were collected Professor Timberlake obtained 24 specimens on *Aplopappus acradenia,* and in the same general region, on 23 November, 1933, he had taken it on *Chrysothamnus paniculatus*. *Retrorsus*, Latin, turned backward, i.e., hairs of scutellum.

Oligodranes scapularis, n. sp.

Male.—Length 1.5 mm. Cheeks with straggling white hairs, occipital weals undeveloped; third joint of antennae oval, widest beyond middle, twice as long as greatest depth, notch and thorn distinct; proboscis one-half longer than head-height, palpi one-third as long as proboscis. Thorax mostly dull black, seen from above the prothorax, shoulders and a narrow sagittal V, all connected in front, cinereous, the shoulder triangles continued as a line to back part of notum, sides of notum cinereous extending upwards at transverse suture, a pair of prescutellar spots lightly cinereous; seen from behind, two broad dark gray vittae extending forward from corners of scutellum; pleura dull cinereous; about ten short white scutellar hairs, hairs extending from sides of notum long and white. Abdomen black, sides and venter cinereous, dorsal incisures very narrowly cinereous, ventral incisures narrowly yellow; abdominal hairs scattered. Coxae cinereous, legs otherwise all black. Wings hyaline, marginal cell dull, veins blackish, first basal cell a little longer than second, second submarginal cell three times as long as wide, sections of third vein 1 : 0.6, the branch ending slightly before wing-tip, fourth vein about 1 : 2 : 4, fifth vein 1 : 0.8, anal petiole slightly longer than anterior crossvein; halteres white, base dusky.

Female.—Head brownish cinereous above, cinereous below; front one-half longer than wide, very slightly narrowed behind, occipital weals very weak, postvertical grooves shallow, hairs of cheeks sparse and short. General color of thorax brownish cinereous, humeri, scutellum and pleura cinereous, two narrow black vittae extending two-thirds, the velvety black sublateral vittae broken into two spots at transverse suture, the anterior round, the posterior elongate triangular. Abdomen when viewed from behind black with distinct white incisures, from the side the segments lightly cinereous.

Holotype and allotype: Oak Grove, on the North base of Mount Palomar, San Diego County, California, 8 May, 1945. *Paratypes:* Three males and nine females, taken with the types; one male and six females, Verdemont, near San Bernardino, California, 25 April, 1946; and four females, same locality, 1 May, 1946; one male, Riverside, California, 26 April, 1937, the last taken by Professor Timberlake on *Cryptanthus intermedia* (C. E. S.). *Scapularis*, referring to the long shoulder marks.

Oligodranes scapulatus, n. sp.

Male.—Length 2.5 mm. Body deep velvet black, notum with long cinereous shoulder triangles. Front rather dull silvery, face with four hairs, cheeks as wide as basal antennal joints, occiput subshining black, weals small, postvertical grooves rather deep; eyes contiguous two-thirds the distance to antennae; first antennal joint smaller than second, third joint broadly elliptical, about twice as long as deep, sulcus and thorn evident; proboscis less than head-height, thick, straight, palpi slender, nearly as long as proboscis. Thoracic hairs long, delicate and straggling, but more bunched behind humeri, scutellar disk bare; a narrow sagittal dark cinereous stripe between the shoulder triangles which reach two-thirds to the suture line; pleura black, mesopleura with a few hairs. Hairs of abdomen fine and scattered. Legs wholly black. Wing veins uniformly blackish, costal ratio between first and third veins 1 : 0.5 : 0.75, sections of third vein 6 : 5, the branch ending before wing-tip, fourth vein 1 : 3 : 2.5, fifth vein 3 : 1, anal petiole equal to anterior crossvein, ambient vein evanescent beyond third vein; alulae sordid beyond the black base, halteres blackish.

Female.—Upper part of head brownish, lower part dark cinereous, front one-fourth longer than breadth at antennae, the anterior part becoming cinereous, weals very small. Notum deep brown, marked with cinereous shoulder triangles, but without the sagittal cinereous stripe, sides with cinereous triangles extending up suture, posterior calli and a pair of vague prescutellar spots somewhat cinereous, pleura dark cinereous. Abdomen black, incisures very narrowly yellowish.

Types: Five males and ten females, collected by P. H. Timberlake at The Gavilan, Riverside County, California, 13 June, 1938, on Greasewood, *Adenostoma fasciculatum*. Types in collection of Citrus Experiment Station.

Oligodranes sipho, n. sp.

Figure 4

Male.—Length 3 mm. A well marked species easily recognized by the three white-cinereous triangles on front edge of thorax, white pilose body, long thin proboscis and large discal cell. Sides of face with about eight long hairs, occipital weals rather strong for male; third antennal joint nearly three times as long as deep, elongate obpyriform, with obliquely truncate notch and strong thorn, behind which is a minute setule. The shoulder triangles include the humeri across to the bifurcate forward extension of the opaque jet-black disk and projecting back halfway to the transverse suture, the sagittal triangle narrower, sides

of notum with cinereous triangles extending up suture; prothorax, pleura and coxae cinereous; scutellum jet-black, fringed with about twenty long white hairs. Abdomen with long hairs, dorsum black, venter cinereous, sides of tergites more or less cinereous; upper part of pygidium with median groove, lower part with short thick conical caudal projection. Legs wholly black, anterior femora with scattering pile. Wings glassy hyaline, veins blackish, the posterior basal veins light fuscous toward base, first basal cell much longer than second, costal ratio of marginal and first submarginal cell 1 : 1.5, second submarginal cell ending at wing-tip, last section of fifth vein usually as long as posterior crossvein, anal petiole longer than anterior crossvein, no ambient vein; halteres yellow, dusky above.

Female.—Pile of body reduced in length. Front 1.2 times as long as wide, parallel-sided, sides of face with scattering hairs to antennae; proboscis fully four times head-height, slender and curving down, palpi about one-sixth as long as proboscis. Notum quadrivittate with brown, the discal intervittae light brownish cinereous, sides, prescutellar area and scutellum becoming more cinereous, the double median vittae reaching prescutellar area, the lateral vittae notched at transverse suture, a small round blackish supra-alar spot. Yellow margins of abdominal segments not sharply limited in front, tergites basally black, sternites cinereous. Last section of fifth vein slightly longer than posterior crossvein.

Holotype and allotype: Oak Grove, at North Base of Mount Palomar, California, 9 May, 1945, on blue flowers of *Phacelia*. *Paratypes:* Twenty-four males and forty females, collected with the types and at Temecula, California, 10 May, 1945, and at Oak Glen, California, 2 July, 1945, also on a blue *Phacelia*, and at Mountain Home Canyon in the San Bernardino Mountains, California, 9 May, 1946. *Sipho*, Latin, a small tube used for sucking liquids.

Oligodranes speculifer, n. sp.

Male.—Length 4.75 mm. Densely coated with white-cinereous pollen, pilose. Beard extending almost to antenna, sides of face and cheeks half as wide as length of third antennal joint; eyes contiguous halfway from ocellus to antennae, the frontal triangle wider than high, glistening white, ocellar triangle black; basal joints of antenna cinereous, with microscopic hairs above, the first joint a little longer than the spherical second joint, third joint black, 2.5 times the basal two, slender, four times as long as deep, slightly tapering on apical third, the apex with microscopic pit and point; proboscis three times head-height, slender, curving down and then curving up at tip, palpi vestigial, very thin, about one-eighth as long as proboscis. Thorax strongly pubescent, with longer retrorse pile posteriorly and on scutellum, two narrow bare stripes taking the place of the usual colored median vittae, marked with two pairs of polished jet-black spots, one supra-alar and round, the other at inner end of suture and subtriangular, mesopleura and sternopleura pilose. Abdomen long-pilose, thickly overlaid with gray white pollen, first segment and apical half of others whitish. Legs cinereous black except the yellowish knees, base and inside of tibiae and base of tarsi;

front coxae and front femora pilose, posterior femora pubescent, claws and pulvilli nearly as long as last tarsal joint. Wings hyaline, costa and veins to discal cell pale yellowish, blackish apically, ambient vein complete, posterior crossvein strongly sinuous, discal cell large and wide, second vein ending beyond middle of second submarginal cell, third vein ratio 1 : 1 : 1.2, the anterior branch ending at wing-tip, the three sections of fourth vein almost equal, fifth vein 2 : 1, anal petiole shorter than anterior crossvein; halteres white.

Female.—Pile and pubescence shorter. Front trapezoidal, width at antennae equal to length and one-half longer than width at ocellus; occiput wholly white-cinereous, the upper grooves forming a shallow wide V, the weals rather strong and extending nearly three-fourths to the vertex; proboscis more than three times the height of the small head. Claws and pulvilli somewhat smaller than in the male. Veins pale fuscous basally, discal cell normal, third vein ratio 1 : 1 : 1.5, fourth vein 1 : 1 : 2, fifth vein 5 : 4.

Holotype: Tahquitz Canyon, near Palm Springs, California, 23 April, 1944. *Allotype:* Three miles West of Palm Springs, 6 May, 1946, on Indigobush, *Dalea Schotti*. *Paratype:* A female taken with the allotype. This species belongs in a group with ***comosus*** and ***retrorsus***, characterized by the bicolored costa and elongate claws and pulvilli of the male. *Speculifer*, from Latin, ***speculum***, mirror, referring to the glistening notal spots.

Oligodranes togatus, n. sp.

Figure 7

Male.—Length 3 mm. White-pilose. Facial hairs confined to lower half; eyes contiguous two-thirds the frontal length; third antennal joint elongate reniform, twice as long as deep, slightly sulcate above tip, the thorn microscopic; proboscis less than twice head-height, nearly straight, palpi black, thin, one-fourth as long as proboscis. Thorax black, the shoulders white-cinereous, between them a median less dense part, the marginal cinereous pruinosity of mesonotum encroaching on the center of the disk giving a bluish cinereous tone in front of scutellum; when viewed from front the cinereous markings coalesce into an anterior semicircle. Abdomen mostly cinereous, base of tergites dark, venter with white incisures. Legs black, knees very narrowly reddish. Veins basally yellow, second vein ending beyond middle of second submarginal cell, sections of fifth vein usually subequal, anterior crossvein at two-fifths the discal cell, anal petiole shorter than anterior crossvein, ambient vein complete; halteres white.

Female.—Face, cheeks, anterior third of front, first antennal joint, humeri, scutellum, spot above front and hind coxae, knees, more or less of tibiae, first abdominal segment and wide posterior margins of others, and halteres, all bright yellow. Pollen of head and dorsum ranging from golden to cinereous, with corresponding coloration of pubescence, three sublateral brownish spots more or less evident on thorax, one presutural, one postsutural and one supra-alar. Proboscis rigid, porrect, face appearing nearly horizontal due to the absence of pollen on the oral margin at the cheeks, occipital weals and grooves undeveloped.

Holotype and allotype: Morongo, California, 28 September, 1944. ***Paratypes:*** Four males and one female, taken with the types; one male and one female from Quail Spring, 5 October, 1934; one male and ten females from Cactus Flat, San Bernardino Mountains, elevation 6,000 feet, 1 September, 1936, on flowers of ***Chrysothamus stenophyllus*** and ***Gutierrezia lucida***, the last taken by Professor P. H. Timberlake (C.E.S.).

The male is very close to *O. colei* which occurs in the same locality, but the females are totally different, manifesting the same type of dimorphism as is found in *O. knabi*. Of course it is not certain that the two sexes belong together since they were not taken in copulation, though they both feed on the same flowers. In one male the posterior crossvein is sinuous in both wings. The Quail Spring female has the thorax largely cinereous. *Togatus*, Latin, wearing a cape.

Oligodranes trifidus, n. sp.

Figure 11

Male.—Length 3 mm. Body opaque jet black, the pile long, delicate and white. Third antennal joint with the preapical notch deep, the thorn stout and before it an evident setule; proboscis one-half longer than head-height, palpi slender, half as long as proboscis. The white-cinereous thoracic pattern consisting of broad shoulder triangles and a nearly parallel-sided or narrowly triangular sagittal stripe, separated by forward extensions of the opaque black disk, sides of notum with low cinereous triangle the apex on the transverse suture; pleura cinereous, sternopleura with loose pile. Upper part of pygidium flattened on each side of a median groove, lower part blunt with a small semicircular setulose expansion near middle of inside edge. Legs wholly black, but with cinereous coating. Wings pure hyaline, veins strong, first basal cell a little longer than second, costal ratio of marginal and submarginal cells 1 : 2 : 1, fourth vein 1 : 3 : 3.5, fifth vein 1 : 0.6, anal petiole slightly longer than anterior crossvein, ambient vein very thin; alulae whitish but base and rim black, the fringe white; stalk and upper side of knob of halteres usually black or blackish.

Female.—Hairs much shorter than in male. Head brownish cinereous above, more gray below, front square, slightly widened at antennae, occipital weals weak, postocellar grooves shallow; proboscis twice head-height, straight, palpi half as long as proboscis. Notum bounded by dull cinereous, the disk seal brown, with the two median vittae, two rounded sublateral and one smaller supra-alar spots quite black, scutellum dull cinereous with about fourteen marginal hairs. Upper side of abdomen black, lightly dusted, incisures yellow, cinereous triangles at sides of tergites, venter cinereous, with corresponding yellow incisures. About half of the rim of the alulae brownish; halteres paler.

Type and allotype: Sheep Creek Canyon, near Phelan, California, 24 May, 1945. *Paratypes:* Eleven males and six females taken with the types; three males from Pala, California, 6 June, 1945; one male and three females, Mountain Home Canyon in the San Bernardino Mountains, California, 9 May, 1946. *Trifidus*, Latin, cleft into three parts, i.e., the cinereous color pattern of the thorax.

THE EFFECT OF DDT ON THE METABOLISM OF THE JAPANESE BEETLE, POPILLIA JAPONICA NEWMAN[1]

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DDT is extremely toxic to certain insects, but precise information concerning its mode of action is lacking. Histological studies have failed to show any significant morphological changes following exposure. Hence, it is likely that the insecticide acts on metabolic processes of the insect, producing modifications which eventually lead to its death. To determine whether such modifications occur, normal insects and others poisoned with various concentrations of DDT were compared with respect to weight, rate of desiccation over anhydrous $CaCl_2$, and the content of water, glycogen, glucose, fat, and protein. This information may assist in understanding the action of the compound and may eventually lead to the production of more effective insecticides and methods of insect control.

The Japanese beetle was selected for this study because it is easily reared in the laboratory, its larvae may be obtained in the vicinity of New York City in considerable numbers from August to June, and the adults are very abundant during July and August. Furthermore, a considerable amount of work has already been published on the physiology of this insect. In the present experiments, the egg, the third-instar larva, pupa, and adult stages were used. They were maintained at a temperature of 25° C. throughout the experiment. Highly purified (standard) DDT, melting point 108.6 to 109.5° C., dissolved in peanut oil was used. Since the experimental procedure differed for each stage of the life cycle, an account of the method will be given in each section of the paper.

EFFECT OF DDT ON THE EGG

Groups of approximately 100 eggs, on successive days of embryonic development, were exposed by placing them for a 10 minute period in a petri dish on the surface of filter paper moistened with a 5% or a 10% solution of DDT. The eggs were rolled on the paper so that the entire surface was moistened with the solution. To serve as controls, comparable series of eggs were exposed in a similar manner to peanut oil without DDT. Before and after exposure, the eggs were kept on the surface of moist soil in 1-ounce metal salve boxes. Observations were made on the number of larvae which formed within the egg, on the number which hatched, and on the duration of the egg stage. The results, given in Table I, show a relatively high mortality when newly laid eggs were exposed to peanut oil or to DDT solutions, probably caused by heavy growths of molds. DDT had no effect on embryonic

[1]The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and New York University.

development. However, it did result in a slight retardation of hatching when the eggs were exposed early in development. Embryogeny was completed in the normal period of time, as evidenced by the appearance of the larval jaws and the outline of the body which are visible through the chorion, but the larvae had difficulty in breaking through the chorion and thus hatching was delayed. No corresponding delay in hatching was noted in the peanut oil series. The larvae which emerged from the eggs exposed to DDT showed characteristic tremors, probably caused by contact with the poison after hatching.

TABLE I

EFFECT OF DDT ON EMBRYONIC DEVELOPMENT

Age of Eggs (days)	Peanut Oil Controls				5% DDT				10% DDT			
	No. of eggs	% hatched	% developed	Duration of egg stage (days)	No. of eggs	% hatched	% developed	Duration of egg stage (days)	No. of eggs	% hatched	% developed	Duration of egg stage (days)
Newly laid	150	78.0	80.0	12.5	98	80.5	81.6	12.7	101	64.3	67.3	13.3
1	100	93.0	93.0	12.2	102	84.3	88.2	13.2	110	87.3	92.7	13.5
2	100	87.0	87.0	12.4	100	91.0	93.0	14.0	135	88.1	96.3	13.7
3	150	93.3	95.3	12.3	112	92.8	95.5	13.3	111	92.8	99.1	14.2
4	100	95.0	96.0	12.4	108	90.7	92.6	12.9	94	89.3	92.5	12.9
5	100	97.0	97.0	12.1	106	94.3	99.0	12.5	112	92.8	99.1	13.0
6	102	95.1	96.1	12.1	109	96.3	96.3	12.1	112	94.6	97.3	12.4
7	100	98.0	98.0	12.0	100	93.0	97.0	12.2	112	96.3	99.1	12.6
8	100	98.0	98.0	12.1	112	94.6	95.5	12.0	95	91.6	96.8	12.1
9	105	100.0	100.0	12.1	100	99.0	100.0	12.0	96	100.0	100.0	12.1
10	101	97.1	97.1	11.9	99	97.0	97.0	12.2	94	99.0	99.0	11.9

EFFECT OF DDT ON THE LARVA

Weight and water content.—Larvae were poisoned by placing them for a 10 minute period in a petri dish on the surface of filter paper moistened with the desired concentration of DDT. They were weighed on a chainomatic balance, exposed to DDT, the excess oil blotted off with filter paper, and then placed in individual 1-ounce metal salve boxes containing moist soil. Weight readings were made at least once daily until death, when the larvae were completely desiccated by keeping them in an oven at 65° to 75° C. until constant weight readings were obtained. Water content was calculated from weight readings made before and after complete desiccation. Normal water content was determined by completely desiccating a number of normal larvae of each series to serve as controls for the poisoned ones. Desiccation procedures were of two types: (1) individuals were kept in a drying oven until their weights were constant; and (2) individuals were desiccated over anhydrous $CaCl_2$ until constant weights were obtained. The two methods produced identical results.

Exposure to a 1% solution of DDT resulted in the poisoning of only 6 of the 21 larvae used. Twelve of the remaining individuals went through a normal metamorphosis. The average weight of this series

during the two weeks immediately following exposure (figure 1) fluctuated between 88% and 100% of its original value. Exposure to 5% or 10% DDT resulted in the death of all of the larvae. The graphs in figure 1 show that in these series a very rapid loss of weight occurred during the first 4 days following exposure, after which the weight remained almost constant for several days. Those larvae which sur-

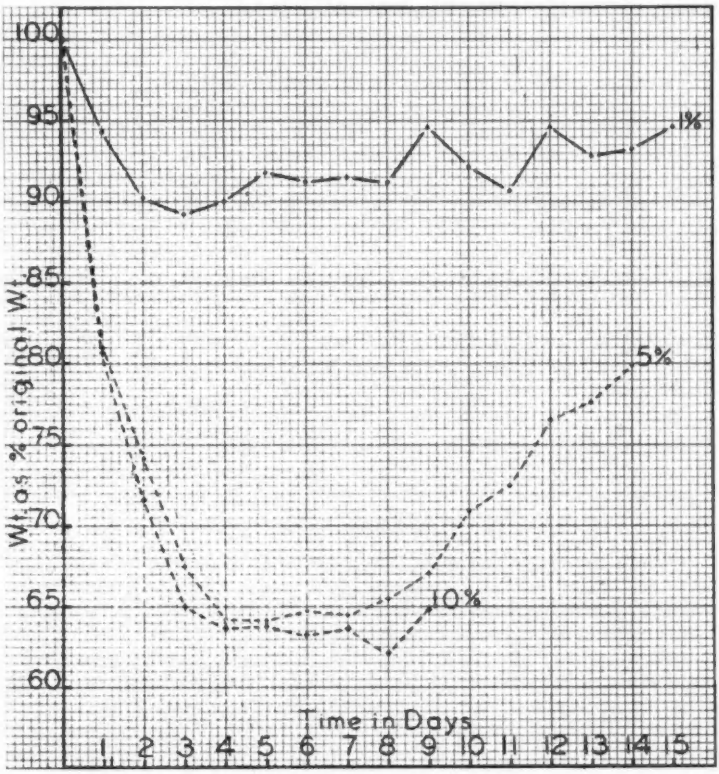

FIGURE 1. Rate of weight loss of third instar larvae after exposure to DDT solutions. Numbers indicate the concentration of DDT used.

vived longer than 7 or 8 days showed a gradual increase in weight until death occurred.

The rapid loss of weight following exposure to DDT suggested that poisoning affects the water balance of the individual. To test this hypothesis, normal larvae, larvae exposed to peanut oil, and others poisoned with 5% and with 10% DDT were placed in desiccators over

anhydrous $CaCl_2$ and weight readings were made daily until constant weights were obtained. Each series consisted of 25 larvae. The changes in weight are shown in figure 2. Normal individuals and those exposed to peanut oil without DDT lost weight at a slower rate than poisoned ones. No significant differences in the rates of weight loss were evident in those poisoned with 5% or 10% DDT. The poison

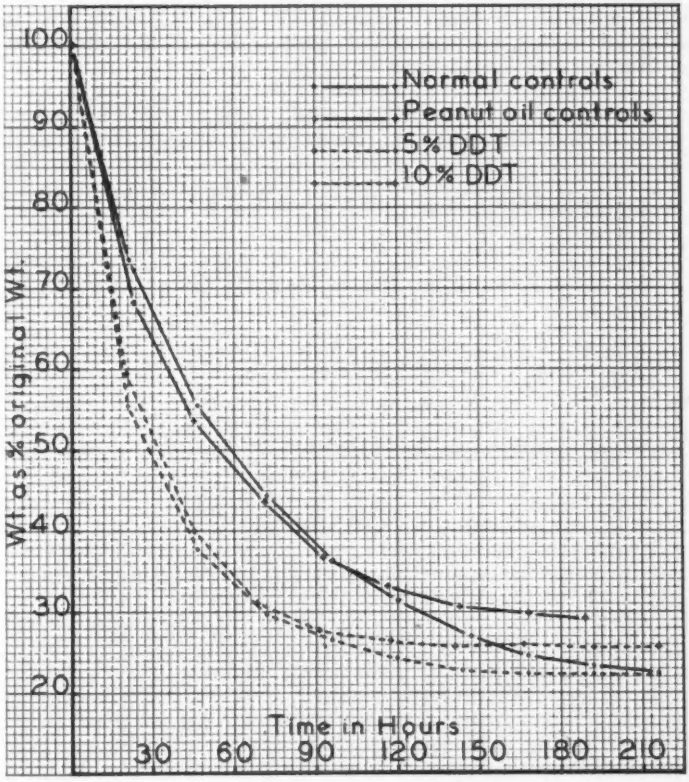

FIGURE 2. Rate of weight loss over anhydrous $CaCl_2$ of normal and poisoned third instar larvae.

appears to interfere with the ability of the larva to resist desiccation. Its effect might result from the greater activity of the poisoned larva, with the increased production and loss of metabolic water.

Table II contains a summary of the weight and water content changes of the larva following DDT poisoning. These data indicate that poisoned larvae lose about one-third of their weight before death

without a reduction in the relative amount of water which they contain. To determine whether their high water content may have been the result of the reabsorption of water from the moist soil during the latter part of the survival period, 20 larvae were exposed to 5% DDT and their water content determined after 4 days. In this series, the average weight loss was 56.5 milligrams, and the water content was 74.0% as compared with a water content of 72.8% for normal larvae of this group. Since the maximum weight loss occurred during the first 4 days following poisoning and since larvae maintained their normal percentage of water during this period, the weight loss must be due to the loss of other constituents as well as of water.

TABLE II

EFFECT OF DDT ON THE WEIGHT AND WATER CONTENT OF THE JAPANESE BEETLE

Stage	No. of beetles	Conc. of DDT (%)	Original weight (mg.)	Weight loss (mg.)	Time of survival (days)	Water content at death (%)	Normal Number used	Beetles water content (%)
Larva.....	43	10	196.4	67.6	5.3	79.0 ± 0.40	45	77.6 ± 0.33
"	15	10	238.4	86.8	7.4	73.7 ± 0.85	65	72.2 ± 0.23
"	21	5	224.5	62.5	7.9	79.4 ± 0.72	45	77.6 ± 0.33
Pupa.....	23	10	175.7	0.4	Pupa	metamorphosed		
"	10	5	177.8	0.3	"	"		
Adult.....	49	5	99.4	11.9	2.0	62.8 ± 0.32	89	67.8 ± 0.21
"	27	1	95.0	12.9	2.2	62.1 ± 0.23	"	" "
"	25	0.50	98.9	13.1	2.5	63.4 ± 0.34	"	" "
"	23	0.33	105.3	10.4	2.4	63.4 ± 0.28	"	" "
"	25	0.20	110.9	15.5	3.8	64.1 ± 0.36	"	" "
"	25	0.17	100.5	21.1	7.9	64.7 ± 0.36	"	" "
"	25	0.13	99.6	19.3	7.9	65.6 ± 0.31	"	" "
"	25	0.10	100.0	15.5	7.4	65.6 ± 0.40	"	" "
"	25	controls (not fed)	100.4	17.2	8.0	65.4 ± 0.35	"	" "

Biochemical changes.[2]—The above observations led to a study of the composition of normal and poisoned individuals to determine what constituents are lost. In these experiments 25 larvae were used in each series. Determinations of fat were made by the ether extraction of dried larvae in a soxhlet apparatus. The larvae were weighed, dried to a constant weight, pulverized with specially purified sand (see Bloor, 1929, p. 282) and transferred to the soxhlet apparatus. Extractions were continued until no additional residue was obtained when the ether was allowed to evaporate. Determinations of glycogen were made according to the method of Good, Kramer, and Somogyi (1933) as modified by Steel (1937). Glucose was determined by the Hagedorn and Jensen technique (Hawk and Bergeim, 1931, p. 435). Protein determinations consisted first in determining the total nitrogen by the

[2]The writer is indebted to Professor K. Brunings, Department of Chemistry, New York University, for suggestions regarding the biochemical procedures used in this paper.

micro-Kjeldahl procedure (Niederl and Niederl, 1938, pp. 51–59) as modified by Wagner (1940), and multiplying the nitrogen value by the protein conversion factor, 6.25.

Soon after exposure to DDT the larva becomes very active and eliminates a considerable quantity of fecal material. The amount of this material was determined by poisoning 25 larvae by a brief contact with a 10% solution and then placing them in covered petri dishes on the surface of weighed filter paper. At the end of 5 hours the filter paper was again weighed and the increase in weight was assumed to be the weight of the feces.

TABLE III

COMPOSITION OF NORMAL LARVAE AND OF OTHERS KILLED BY CONTACT WITH 10% DDT, WITH AN ANALYSIS OF THE WEIGHT LOST BY POISONED LARVAE

	NORMAL LARVA		LARVA KILLED WITH DDT READINGS AT TIME OF DEATH		AMOUNT LOST WEIGHT (mg.)
	Per Cent	Weight (mg.)	Per Cent	Weight (mg.)	
		196.4		128.8	67.6
Water	77.63 ± 0.33	152.47	79.02 ± 0.40	101.79	50.68
Fat	3.91 ± 0.15	7.68	4.01 ± 0.17	5.16	2.52
Glycogen	0.63 ± 0.052	1.24	0.14 ± 0.018	0.18	1.06
Glucose	0.53 ± 0.011	1.04	0.48 ± 0.023	0.62	0.42
Protein	9.70 ± 0.18	19.05	14.56 ± 0.34	18.75	
*Feces	7.40 ± 0.31	14.53			14.53
Total	99.8		98.2		69.21

* Determined by weighing the material eliminated by 25 larvae during the 5-hour period following exposure to DDT.

A summary of the analysis of normal larvae and of others within a few hours after death from DDT poisoning is shown in Table III. The percentage values for water, fat, and glucose are not statistically different for normal and poisoned larvae. However, since the weight of the larva killed by DDT is only about two-thirds of its original value, the weights of these compounds are significantly lower in the poisoned than in the normal individuals. The glycogen content of the larva killed with DDT is almost depleted and the per cent of protein has increased. There is no change in the amount of protein since its weight in normal larvae is not statistically different from that in poisoned ones at the time of death. The weight lost as a result of DDT poisoning is due to a reduction in the amount of water, feces, fat, glycogen, and glucose. The fat, glycogen, and glucose are the compounds which furnish energy for muscular activity and their loss is associated with the violent muscular tremors which accompany DDT poisoning.

Respiratory metabolism.—Respiratory readings were made on larvae poisoned with 10% DDT using the modified Krogh manometer (Bodine and Orr, 1925). All readings were made at a constant temperature of 25° C. Thirty-seven individuals were poisoned but only 5 of them survived beyond the sixth day after exposure. The graphs (figure 3)

were constructed from the averages of the larvae which survived on each day of the experiment. Since the weight of the larva decreased rapidly following exposure, the values are expressed as cu. mm. 0_2 per larva as well as per gram body weight. DDT poisoning results in an increase in 0_2 consumption which becomes evident about 2 hours after

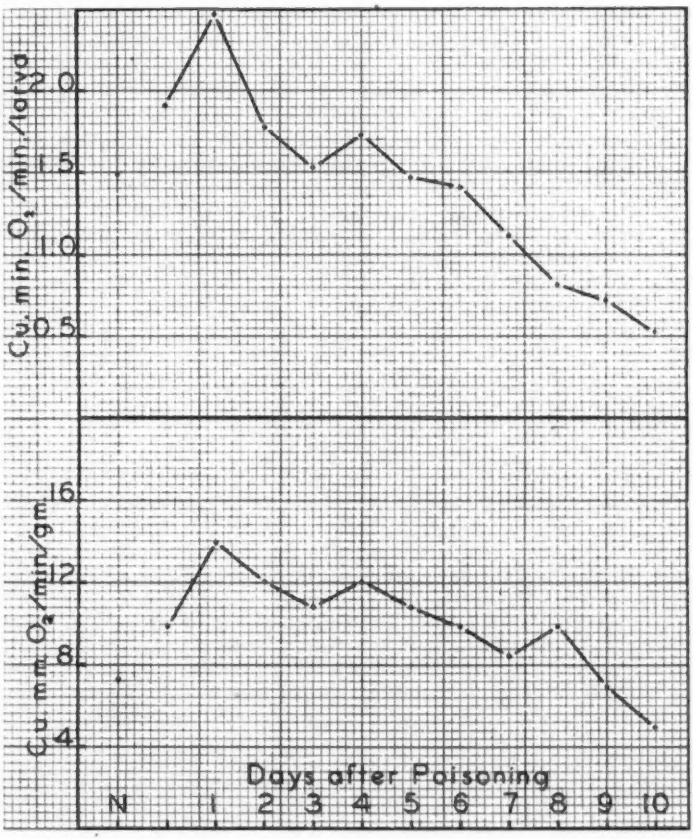

FIGURE 3. Rate of oxygen consumption of third instar larvae following exposure to 10% DDT. N, indicates the rate of normal larvae.

exposure. The rate continues above normal for about 5 days, after which it declines until the larva dies. The period of increased 0_2 consumption corresponds with that during which the larva is undergoing characteristic tremors and the increase in metabolism is probably caused by increased activity. The respiratory quotients varied between 0.7

and 0.8 during the first 2 days, after which they dropped to values ranging between 0.6 and 0.7.

EFFECT OF DDT ON THE PUPA

Pupae were exposed by placing them for a 10 minute period in a petri dish on the surface of filter paper moistened with 5% or 10% DDT

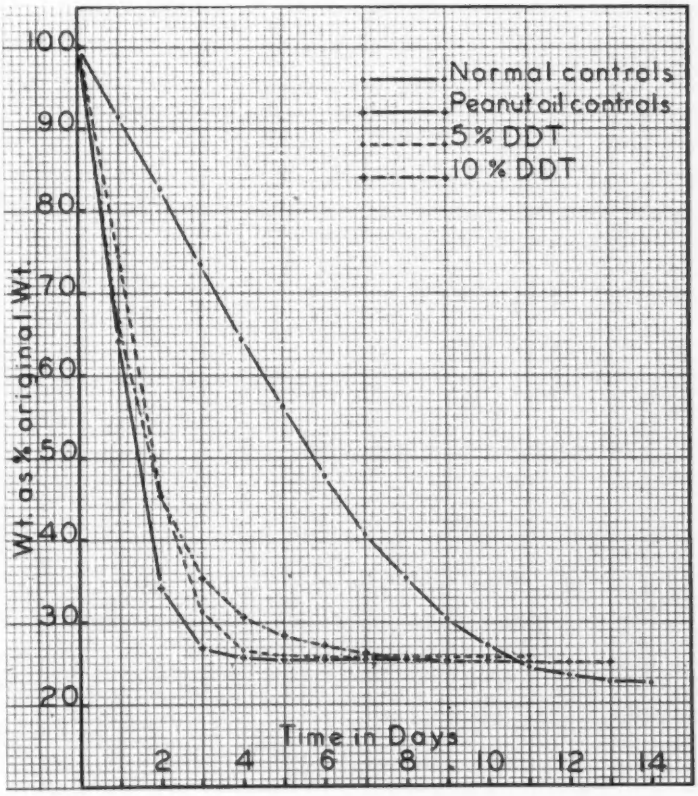

FIGURE 4. Rate of weight loss over anhydrous $CaCl_2$ of normal pupae, and of others exposed to DDT or to peanut oil.

solutions. After exposure they were placed on the surface of moist soil in individual 1-ounce metal salve boxes. Daily weight readings were made until emergence or until death. Both early and late pupae were used in these experiments. No definite signs of poisoning were noted in the exposed pupae. Weight readings were normal throughout

pupal development (Table II) and there were no characteristic muscle tremors, although the normal pupa is relatively active. Of 10 pupae exposed to a 5% solution, 9 produced adults. Some of them showed tremors, probably due to contact with the poison during or after eclosion. Of 23 pupae exposed to a 10% solution, 17 produced adults all of which showed signs of poisoning. In four cases abnormal emergence resulted. The abdomen remained large as in the pupa,

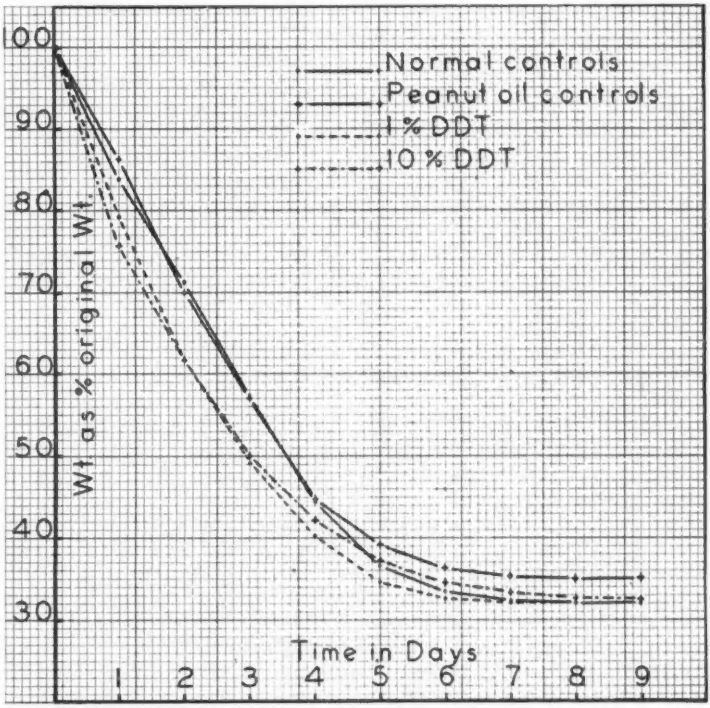

FIGURE 5. Rate of weight loss over anhydrous $CaCl_2$ of normal and poisoned adults.

portions of the pupal skin remained attached to the abdomen and the wings, and the adults were unable to spread their wings. This abnormal emergence may indicate a penetration of the DDT into the pupa although no signs of poisoning were visible until the time of emergence.

Groups of 25 pupae were exposed to 5% DDT, 10% DDT, and peanut oil without DDT and desiccated over anhydrous $CaCl_2$ to compare their rates of weight loss with those of a comparable series of normal pupae. The results (figure 4) show that pupae exposed to

peanut oil lost weight as rapidly as those exposed to 5% or 10% DDT solutions and at a much faster rate than did normal pupae. Hence, the greater rate of desiccation of the exposed pupae appears to be associated with some physical action of the oil on the water permeability of the cuticle. The oil might bring about this effect by dissolving a waxy covering from the surface of the pupa.

EFFECT OF DDT ON THE ADULT

Weight and water content.—Adult beetles were poisoned with DDT according to the procedure outlined above for larvae and pupae and also

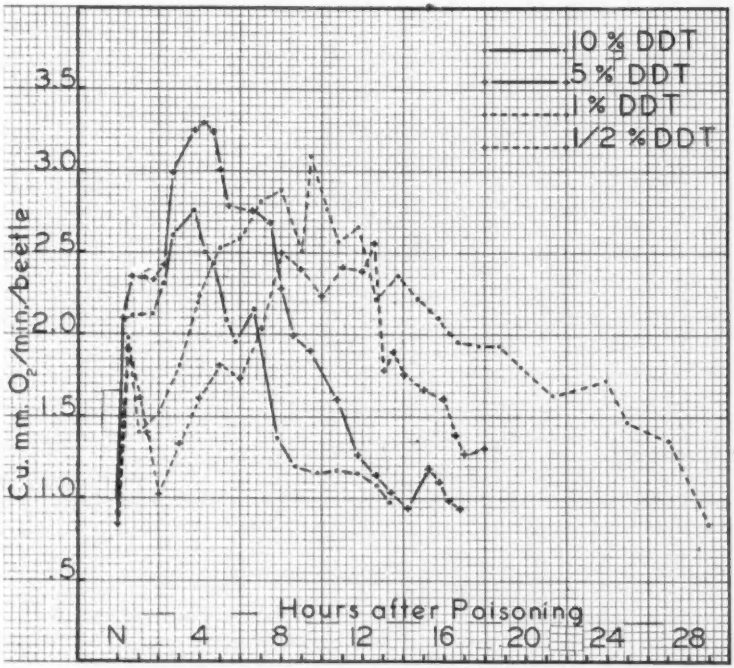

FIGURE 6. Rate of oxygen consumption of adults following exposure to different concentrations of DDT. N, indicates the rate of normal adults.

by placing a small drop of a peanut oil solution on the front of the head. Their subsequent treatment was the same as that described for the larvae. Changes in weight and water content are summarized in Table II. The table shows that under the conditions of the experiment, DDT is toxic to adult beetles in concentrations as low as 0.2%. At lower concentrations, the insects probably died of starvation. Since the

normal water content of adults averages 67.8% there is a slight but significant loss of water in the control series (normal adults kept in moist soil but without food) and in those subjected to sublethal concentrations of DDT. However, the water loss is slightly greater in those which died of poisoning. In the table, differences in the average water content of adults as small as 1.5 % are statistically significant. Hence, adults exposed to concentrations of 0.33 %or greater have a reduced water content as compared with the control series. The loss of water is sufficient to account for nearly all of the weight lost by the poisoned individuals.

Groups of 25 adult beetles exposed to 1% DDT, 10% DDT, and peanut oil without DDT were desiccated over anhydrous $CaCl_2$ and their rates of weight loss compared with that of a comparable series of normal adults. The results are plotted in figure 5. Normal adults and those exposed to peanut oil without DDT lost weight at a slower rate than poisoned individuals. No significant differences were noted between those poisoned with 1% and 10% DDT. This greater rate of weight loss in poisoned adults, as in the case of the larvae, may be associated with their greater muscular activity.

Respiratory metabolism.—Readings were made on the rate of O_2 consumption of adult beetles poisoned with various concentrations of DDT. All readings were made at 25° C. The results are shown graphically in figure 6. Those poisoned with 5% or 10% DDT showed an immediate increase in O_2 consumption, the rate at the end of 15 minutes being more than twice the normal value. Two hours after exposure the rate again increased reaching a maximal value at the end of 4 hours. There was then a rapid decrease which continued for 9 hours after exposure to 10% and for 12 hours after exposure to 5% DDT. The oxygen consumption of adults poisoned with 1% or 0.5% increased rapidly and at the end of 30 minutes was about twice the normal value. There was then a marked decrease in rate until 2 hours after exposure when it again increased, reaching a maximal value in 10 hours with a 1% solution and in 13 hours with a 0.5 % solution. The maximal values averaged between 3 and 4 times the normal rate regardless of the concentration of DDT used. Oxygen consumption readings were also made on adults poisoned with 0.2% DDT. In this series, there was no marked increase in rate, the values rising to a point slightly above normal and remaining there for a period of 2 days. An attempt was made to correlate the increase in respiratory metabolism with the presence of DDT tremors. It was noted that those insects which showed violent tremors also used oxygen very rapidly, while those which showed only slight muscular activity used oxygen slowly. The increase in metabolic rate of the poisoned insect appears to be the result of its increased activity.

DISCUSSION

The differences in susceptibility manifested by the various stages in the life cycle are difficult to explain. The egg and pupa show no signs of poisoning even when exposed to a 10% solution of DDT. There is some evidence that the poison is able to penetrate the chorion of the

egg and the cuticle of the pupa, since hatching was delayed when exposure occurred early in embryonic development and many adults showed imperfect emergence after exposure of the pupae. It was found that most larvae survived a 10 minute exposure to a 1% solution and went through a normal metamorphosis, whereas adults were killed by a brief contact with 0.2% solution. This difference in susceptibility may be correlated with the relative amount of active tissue in the larva and adult. The third-instar larva weighs approximately 200 milligrams and possess a relatively small amount of exoskeleton; whereas, the adult weighs only about 100 milligrams and has a very thick, heavily sclerotized, exoskeleton.

When poisoned, the larvae and adults manifest certain differences which may be correlated with physiological differences between the two stages. The poisoned larva maintains its normal water content although it loses approximately one-third of its original weight before it dies. The adult loses approximately one-tenth of its original weight before death and this loss is accompanied by a reduction in water content. In both stages this weight loss occurs while the insect is in a moist environment and in contact with moist soil. The adult evidently requires the ingestion of succulent food in order to maintain its normal water content, since normal unfed adults lost significant amounts of water when kept in salve boxes in contact with moist soil (Table II). On the other hand, the starved larva is able to absorb water from moist soil and regain its normal water content after suffering partial desiccation in a relatively dry environment. One important difference between the two stages is associated with the elimination of a considerable quantity of feces by the poisoned larvae whereas very little fecal material is eliminated by poisoned adults. The gut of the larva normally contains a large amount of soil. This soil is entirely eliminated by the normal insect at the beginning of metamorphosis, and most of it by the poisoned larva soon after exposure to DDT. Furthermore, larvae survived an average of 5 to 8 days after exposure, while most adults died within 2 or 3 days. During this time the larva uses practically all of its glycogen and some of its fat and glucose. Respiratory quotient readings on poisoned larvae indicate that carbohydrates and fats are oxidized during the first 2 days after exposure, following which the fat reserve is utilized. The only comparable experiments made on the adult were of total fat content. The normal adult was found to have $2.64 \pm 0.09\%$; and the adult which had died of DDT poisoning, $3.35 \pm 0.11\%$ fat. Since poisoned adult beetles lose weight and water following exposure, the amount of fat remains practically unchanged. It seems likely that the only food used by the adult during tremors is of a carbohydrate nature.

The rate of oxygen consumption following exposure to DDT increased to nearly 2 times its normal value within 24 hours in the larva, and to 3 or 4 times the normal value within several hours in the adult (figures 3 and 6). The increased oxygen uptake in both cases is correlated with increased muscular activity and is present only as long as the insect shows characteristic DDT tremors. These results are in agreement with those of Barron (1945) who found that the oxygen uptake of the meal worm beetle, *Tenebrio molitor*, increased about 3 to 5 fold following

a one and one-half hour exposure to a film of solid DDT. Barron believes that the increased oxygen uptake is caused by increased activity since both muscle tremors and increased oxygen consumption were eliminated by the use of narcotics. Further evidence that increased activity is the cause of the acceleration in the rate of oxygen utilization is found in the observation by Barron that the respiration of grasshopper eggs in diapause is not affected by exposure to DDT in 70% alcohol, and the eggs within 2 days of hatching showed a slight inhibition of respiration after DDT treatment.

The observation that the glycogen supply of the larva poisoned with DDT was almost depleted at the time of death is in agreement with the results obtained by other workers following the administration of DDT to mammals. Lauger, Pulver, and Montigel (1945) were the first to demonstrate the depletion of liver glycogen following DDT ingestion. Their work was verified by Barron (1945) who showed that in rats, sacrificed 3 to 5 hours after the ingestion of DDT and while having strong muscle tremors, the blood sugar and liver glycogen were reduced, and the blood lactic acid increased. In rats treated with DDT, but kept quiet by the injection of nembutal, these compounds were present in normal amounts. Thus the reduction in the glycogen supply of the poisoned animal appears to be the result of increased muscular activity.

The metabolic changes following exposure to DDT (such as increased activity, increased oxygen utilization, loss of glycogen, glucose and fat) suggest the possibility that, in the Japanese beetle larva, death may be the result of a depletion of the readily available energy supply. The increased muscular activity is induced in some manner by the action of DDT. It results in a rapid utilization of the carbohydrate reserve, after which the insect dies. Evidence that starvation is a factor in the death of this insect following exposure to DDT may be obtained from the fact that the stage which is able to survive a relatively long period of starvation is also able to survive a relatively long time following DDT poisoning. The unfed Japanese beetle larva survives an average of 30 days (Ludwig and Landsman, 1937), whereas the unfed adult can live only 8 days (Table II). When poisoned, the larva survives an average of 5 to 8 days and the adult dies in 2 to 3 days. The observation that the protein content of the larva remains unchanged following DDT poisoning does not invalidate this hypothesis, since Wigglesworth (1939) pointed out that "in some insects there appears to be no utilization of proteins at all during fasting."

SUMMARY

1. Different stages in the life cycle of the Japanese beetle vary greatly in their susceptibility to DDT. Embryonic development is not affected, but when the eggs are exposed early in development, hatching is delayed. Exposed pupae show no characteristic signs of poisoning, but in some cases, an abnormal emergence from treated pupae occurs. The larvae are killed by contact with 5% or 10% solutions and the adults by contact with 0.2% solutions in peanut oil. This difference in susceptibility may be correlated with the relative amount of active tissue in the larva and adult.

2. Poisoned larvae maintain their normal per cent of water

although they lose approximately one-third of their original weight. The decreased weight is the result of a loss of water, feces, glycogen, glucose, and fat. No significant loss of protein occurs in DDT poisoned larvae. Poisoned adults lose approximately one-tenth of their original weight and this loss is accompanied by a reduction in water content.

3. Poisoned larvae and adults lose water over $CaCl_2$ at a greater rate than the corresponding stages of normal insects. DDT appears to affect the ability to withstand desiccation. Its action may be correlated with the increased activity of the poisoned insect with the resulting greater rate of production and loss of metabolic water. Pupae exposed to peanut oil without DDT or to DDT solutions in peanut oil lose weight over $CaCl_2$ at a greater rate than normal pupae. In this case, the greater loss of weight of the treated insects is believed to be associated with some physical action of the oil on the water permeability of the cuticle. The oil may bring about this effect by dissolving a waxy covering from the surface of the pupa.

4. DDT poisoning of the larva results in an increase in the rate of oxygen consumption which becomes evident about 2 hours after exposure and reaches a maximal value of 2 times the normal rate within 24 hours. The rate continues above normal for 5 days, after which it declines until the animal dies. Adults poisoned with DDT show an immediate increase in oxygen utilization, the rate reaching 2 times the normal value in 15 minutes with high concentrations, and in 30 minutes with low concentrations of DDT. The maximal value averages 3 to 4 times the normal rate regardless of concentration. The increased oxygen consumption in both stages is correlated with increased muscular activity and is present only as long as the insect shows characteristic tremors.

5. The metabolic changes following a lethal exposure to DDT suggest that, in the Japanese beetle larva, the increased muscular activity associated with DDT poisoning results in a rapid utilization of the carbohydrate reserve after which the insect dies.

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THE EFFECTS OF THE WAR ON JAPANESE ENTOMOLOGICAL PUBLICATIONS

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Cambridge, Massachusetts

There are nine continuous periodicals in Japan devoted entirely to papers on insects. Two of these are published exclusively in European languages, three contain papers in both Japanese and foreign languages, and the remaining four are in Japanese, with a few English or German resumés. The lack of paper and type forced the discontinuance of all nine of these periodicals by March of 1945. None had recommenced publication when the writer left Japan at the end of January, 1946. Entomologists and librarians in the United States may find it desirable to know exactly the last number of each periodical to appear. The nine journals follow in order of importance to entomology. The notation "(For.)" means that all papers are in European languages, principally German and English; "(Jap.)" indicates papers in Japanese characters; and "(For. & Jap.)" means some papers are in Japanese, others in foreign languages. For each periodical are given the volumes and years published, the date of enforced discontinuance, the publisher, and a note on the contents.

1) *Insecta Matsumurana* (For.), Vol. I–XVI (1926–1942).
   Discontinued publication December, 1942.
   Published by the Entomological Institute, Hokkaido Imperial University, Sapporo, Japan.
   Principally taxonomic papers including all orders, by students and associates of Professor Matsumura.
2) *Kontyu* (For. and Jap.), Vol. I–XVI (1926–1944).
   Discontinued August, 1944.
   Published by the Entomological Society of Nippon, Tokyo, Japan.
   Taxonomic papers on all orders.
3) *Mushi* (For. & Jap.), Vol. I–XV (1924–1943).
   Discontinued January, 1943.
   Published by the Fukuoka Entomological Society, the Entomological Laboratory, Kyushu Imperial University, Fukuoka, Japan.
   Taxonomic papers on all orders.
4) *Transactions of the Kansai Entomological Society* (For. & Jap.), Vol. I–XIV, pt. 1 (1930–1944).
   Discontinued February, 1944.
   Published by the Kansai Entomological Society, Kotoen, near Kobe, Japan.
   Taxonomic papers on all orders; written principally in Japanese.
   Formerly important; now much less so.

5) *Tenthredo, Acta Entomologica* (For.), Vol. I–IV (1936–1942).
Discontinued November, 1942.
Published by the Takeuchi Entomological Laboratory, Shinomiya, Yamashina, Kyoto, Japan.
Published and edited by Takeuchi, Japan's distinguished sawfly authority. Papers mostly on taxonomy of Lepidoptera and sawflies.

6) *Oyo-Kontyu* (Jap.), Vol. I–IV (1938–1943).
Discontinued October, 1943.
Published by the Nippon Society of Applied Entomology, Tokyo, Japan.
Japan's journal of applied entomology.

7) *Zephyrus* (Jap.), Vol. I–IX (1929–1943).
Discontinued October, 1943.
Published by the Entomological Laboratory, Kyushu Imperial University, Fukuoka, Japan.
A well-illustrated periodical entirely on Lepidoptera. Papers principally by Professor Esaki and his students. All papers in Japanese.

8) *Insect World* (Jap.), Vol. I–XLIX (1897–1945).
Discontinued March, 1945.
Published by the Nawa Entomological Laboratory, Gifu, Japan.
Japan's oldest entomological periodical. Printed on very inexpensive paper, with inferior illustrations, and of little international interest.

9) *Kontyu-Kai* (*Entomological World*) (Jap.), Vol. I–XI (1933–1943).
Discontinued December, 1943.
Published by the Insect Lovers' Association, Tokyo, Japan.
Now a minor journal entirely in Japanese and of very little systematic importance.

In December, 1945, vol. I, pt. 1 of the *Transactions of the Nippon Lepidopterological Society* was published by Y. Okada, Yanagidai-cho, Saga, Kyoto, Japan. How long-lived this new journal will be is uncertain. At any rate, it was the first entomological periodical to appear in Japan after the surrender by the Japanese.

The Entomological Institute of the Hokkaido Imperial University is making preparations to publish a new periodical, according to information received from Sapporo in April, 1946. The periodical will be entirely in Japanese and the proposed title is *Matsumushi*. It will not include systematic papers, since these are already handled by *Insecta Matsumurana*, and it will be a companion publication to the latter.

Important entomological papers have appeared in several publications on zoology and natural history. Papers on myriapods and Arachnoidea, groups included in entomological periodicals in America, are also found in these publications. The following are the six most important periodicals in this category:

1) *Transactions of the Sapporo Natural History Society* (For. & Jap.), Vol. I–XVIII (1906–1943).
   Last published in December, 1943.
   Published by the Sapporo Natural History Society, Hokkaido Imperial University, Sapporo, Japan.
2) *Transactions of the Natural History Society of Formosa* (For. & Jap.), Vol. I–XXXIV (1911–1944).
   Discontinued December, 1944.
   Published by the Natural History Society of Formosa, Taihoku Imperial University, Taihoku, Formosa.
3) *Bulletin of the Biogeographical Society of Japan* (For. & Jap.), Vol. I–XIII (1929–1943).
   Discontinued in October, 1943.
   Published by the Biogeographical Society of Japan, Tokyo.
4) *Annotationes Zoologicae Japonenses* (For.), Vol. I–XXII (No. 2?) (1897–1943).
   Discontinued in middle of 1943.
   Published by the Zoological Society of Japan, Zoological Institute, Faculty of Science, Tokyo Imperial University, Tokyo.
5) *Dobutsugaku-Zasshi* (*Zoological Magazine*) (Jap.), Vol. I–LVI, Pt. 6), (1888–1944).
   Discontinued June, 1944.
   Published by the Zoological Society of Japan, Zoological Institute, Faculty of Science, Tokyo Imperial University, Tokyo.
6) *Oyo-Dobutsugaku Zasshi* (*Journal of Applied Zoology*) (Jap.), Vol. I–XV (1929–1944).
   Discontinued July, 1944.
   Published by the Japanese Society for Applied Zoology, Zoological Institute, Faculty of Agriculture, Tokyo Imperial University, Tokyo.

There appears to be no immediate prospect for resumption of publication by any of the Japanese periodicals, particularly those in foreign languages. The few Japanese printers who still had type in Roman letters were swamped with work for American troops and type of any kind was scarce. Paper of a grade acceptable for scientific publications is still unobtainable. However, the barriers to resumption of publication are emphatically mechanical. Most Japanese entomologists, as well as other biologists, have manuscripts ready for the time when publishing is again possible. The papers and books awaiting publication contain many drawings and very beautiful colored plates.

NUTRITION OF ATTAGENUS (?) SP. II.
(Coleoptera: Dermestidae)

WARREN MOORE,[1]
Bon Air, Va.

In a preceding paper (Moore, 1943), I described a partly synthetic ration which supported slow growth of *Attagenus* larvae. Work on the nutrition of the yellow species (Moore and Moore, 1942) has been continued, the insects being handled approximately as already described. About 0.5 gm. of food and twenty newly-hatched larvae were placed in each 2-dram vial. The incubator temperature has been raised from 87° to 90° F. to accelerate growth and, in the more recent work, the humidity has been reduced to 55% to prevent deliquescence of certain amino acid mixtures and to minimize the growth of molds and other unwanted organisms.

The basic ration, described in the preceding paper, was simplified by omitting extracted fish meal, cystine, glucosamine HCl, urea, phytin, β-alanine, and p-aminobenzoic acid, none of which was found to produce consistent increases in growth. Vitamin Test Casein Smaco or Labco Purified Lactalbumin 7 HAAX have been used as sources of protein, usually reinforced with 1% tryptophane. Other lipids have replaced those used previously. All lipids were added shortly (one to two days) before each experiment was started.

FOLIC ACID AND BIOTIN

Since 28 June 43, Professor Roger J. Williams has kindly supplied me with his folic acid concentrates. These concentrates varied in potency from 3100 to 28000, (Mitchell and Snell, 1941). They were dissolved in a volume of aqueous alcohol such that one drop contained about one microgram of potency 40,000.

Biotin Smaco or Merck was used.

Rations had the following approximate compositions:

[1]Acknowledgments are due to Dr. J. C. Forbes and Dr. Herbert McKennis, Jr., of Richmond, Va., and to my father, Dr. J. Percy Moore, of Philadelphia, for suggestions as to the work and for criticism of the manuscript. For technical assistance, I am indebted to my wife, Marion B. Moore, and to Reba Stillman and Isobel C. McGlothlin.

TABLE I

	1	2	3
Lactalbumin 7 HAAX (Labco)	.....	400 mg.	200 mg.
Vitamin Test Casein (Smaco)	350 mg.	.....	.....
dl Tryptophane	.....	.....	5
Corn starch (Argo)	150	100	300
Salts, USP #2	15	15	15
Glycerol	60	60	60
Choline chloride	1.0	0	1.0
Thiamine hydrochloride	0.020	0.020	0.020
Riboflavin	0.010	0.010	0.010
Nicotinic acid	0.080	0.080	0.080
Pantothenic acid	0.025	0.010	0.025
Pyridoxin	0.010	0.004	0.010
Folic acid π 40,000	0	0.001	0.001
Biotin	0	0.0008	0.0004
Inositol	0	0.040	0.040
p-Aminobenzoic acid	0	0.040	0.040
Desynon[2]	4 drops	4 drops	0
Vitamin E solution	1 drop	1 drop	0
Vitamin K solution	1 drop	1 drop	0

[2]Desynon (Winthrop Chemical Company). An alcoholic solution of purified vitamins A and D.

In experiment 259, ration 1 was enriched with folic acid, biotin, and pure, dried, debittered brewers yeast (Vita-Food Red Label). The results appear in Table II.

TABLE II

EFFECT OF ADDING FOLIC ACID AND BIOTIN OR YEAST TO RATION 1

Average weight per larva at four and seven weeks. Twenty newly-hatched larvae per tube. 86° F., 60% R. H. 27 Nov. 43 to 15 Jan. 44.

SUPPLEMENTS			WEIGHT PER LARVA milligrams	
FOLIC ACID micrograms	BIOTIN micrograms	YEAST milligrams	4 weeks	7 weeks
0	0	0	0.4 0.4	0.7 0.6
1	0	0	0.7 0.7	2.8 3.1
2	0	0	0.9 0.7	3.4 3.3
2	0.8	0	0.9 1.0	4.7 4.7
2	0	50	1.1 1.1	5.5 5.4

The results are typical. In a number of similar tests, folic acid always produced a marked increase in growth. A further increase at seven weeks always followed the addition of biotin. The addition of yeast commonly increased the growth rate over that obtainable with the known vitamins.

No reaction followed the addition of inositol, p-aminobenzoic acid, or hesperidine methyl chalcone (vitamin P)[3], separately or in combinations.

In experiments 279, 280, 281, and 282, various foods low in vitamins were enriched with mineral, liver fat 8 mg/gm, a solution of vitamins A, D, E, and K, and synthetic B vitamins including biotin, but omitting folic acid. The food substances used and the weight of larvae at seven weeks appear in Table III.

TABLE III

EFFECT OF ADDING FOLIC ACID TO VARIOUS LOW-VITAMIN FOODS, ALL OTHER KNOWN DEFICIENCIES BEING SUPPLIED

Forty newly-hatched larvae per test (2 tubes). 90° F., 60% R. H.
6 March to 24 April, 44.

FOOD	APPROX MG. PER TUBE									
Vitamin Test Casein (Smaco)	500		500		450		400		304	
l Tryptophane	5		5		5		5			
Glycerol CP			60						52	
Sucrose					50					
Starch cooked							100			
Starch, raw									131	
FOLIC ACID ADDED γ per tube	0	1	0	1	0	1	0	1	0	1
WEIGHT PER LARVA at 7 weeks, mg.	1.1	2.5	1.3	3.7	1.8	3.8	2.8	6.9	1.3	4.9
Lactalbumin 7 HAAX (Labco)	500		500		450		400		400	
Glycerol CP			60						60	
Sucrose					50					
Corn starch, cooked							100		100	
FOLIC ACID ADDED γ per tube	0	1	0	1	0	1	0	1	0	1
WEIGHT PER LARVA at 7 weeks, mg.	0.8	3.8	1.1	4.9	1.2	5.7	1.1	5.4	1.2	5.9

In experiments 318, 319, and 320, various low-vitamin foods were enriched with Desynon, vitamins E and K, mineral, and synthetic B vitamins, excepting biotin. Folic acid concentrate was added to furnish 2 micrograms/gram of the vitamin. Table IV shows the various proteins and carbohydrates used and the weight of the larvae with and without added biotin.

[3]Courtesy of Abbott Laboratories.

TABLE IV

EFFECT OF ADDING BIOTIN TO VARIOUS LOW-VITAMIN FOODS, ALL OTHER KNOWN DEFICIENCIES BEING SUPPLIED

Forty newly-hatched larvae per test (2 tubes). 90° F., 60% R. H. 12 June to 31 July, 44.

FOOD	APPROX. MG. PER TUBE									
Vitamin Test Casein (Smaco)	.....		500		.....		.....		.....	
Lactalbumin 7 HAAX (Labco)	171		.....		500		380		.....	
Raw egg white[4]	50		.....		.....		.....		.....	
dl Tryptophane	4		.....		.....		4		.....	
Glycerol CP	.....		100		100		100		.....	
Corn starch (Argo)	258		.....		.....		100		.....	
BIOTIN ADDED γ per tube	0	0.8	0	0.8	0	0.8	0	0.8	....	....
WEIGHT PER LARVA at 7 weeks, mg.	2.7	5.1	2.7	3.8	3.4	4.6	3.4	5.5	....	....
Lactalbumin 7 HAAX (Labco)	380		380		427		427		427	
dl Tryptophane	4		4		4		4		4	
Glycerol CP	100		100		100		100		100	
Corn starch (Argo)	100		.....		.....		.....		.....	
Soluble starch[5]	.....		100		.....		.....		.....	
Sucrose	.....		.....		50		.....		.....	
Glucose	.....		.....		.....		50		.....	
Galactose	.....		.....		.....		.....		50	
BIOTIN ADDED γ per tube	0	0.8	0	0.8	0	0.8	0	0.8	0	0.8
WEIGHT PER LARVA at 7 weeks, mg.	3.3	4.6	3.6	5.5	3.6	5.7	3.3	4.8	3.0	3.9

[4]Albumin, egg Impalp. Powder Soluble. J. T. Baker Chemical Co.
[5]Starch Soluble Powd. CP Baker analyzed.

Depletion experiments with folic acid have given erratic results. As a rule, the insects have continued to grow indefinitely, although significant mortality often occurred when the experiment was continued for over four months.

Omission of biotin only resulted in slower early growth. In experiment 344, egg albumin was substituted for milk protein and no biotin was added. The insects were still growing after sixteen weeks.

It seems probable that the depletion experiments were complicated by the presence of folic acid and biotin in the basic ration and by bacterial and fungal contamination. Methods of eliminating these difficulties are being studied.

CHOLINE

In experiment 325, using ration 2, choline was omitted. The results appear in Table V.

TABLE V

GROWTH OF *Attagenus* LARVAE WITH AND WITHOUT ADDED CHOLINE CHLORIDE

Number and average weight per larva. Twenty newly-hatched larvae per test. 90° F., 60% R. H. 27 June to 24 Oct., 44.

TUBE NO.	1		2		3	
CHOLINE CHLORIDE AT START, mg.....	0		0		0.4	
	No.	Av. Wt. mg.	No.	Av. Wt. mg.	No.	Av. Wt. mg.
4 weeks.....	17	0.14	17	0.14	20	0.65
7 weeks.....	15	0.25	15	0.21	20	3.55
CHLORINE CHLORIDE ADDED AT 7 WEEKS mg.	0		0.4		0	
9 weeks.....	15	0.28	15	0.53	20	6.25
11 weeks.....	14	0.34	15	1.2	20	7.8
13 weeks.....	12	0.43	15	2.6	.....	.....
15 weeks.....	11	0.54	15	4.0	.....	.....
17 weeks.....	10	0.68	15	4.6	.....	.....

TABLE VI

EFFECT OF ADDING LIPIDS TO RATION 3

Forty newly-hatched larvae per test (2 tubes). Mortality negligible. Weight per larva at four and nine weeks. 90° F., 55–60% R. H. 16 Oct. to 18 Dec., 44.

EXPERIMENT NO.	354	354	355	354	355	
TUBE NOS.....	1–2	3–4	1–2	11–12	9–10	11–12
ADDED CHOLESTEROL mg.	0.08	0.10	1.0	.....	1.0	.....
LIVER FAT mg.	.....	.....	.....	4	.....	4
YEAST mg.	.....	.....	.....	.....	50	50
WEIGHT PER LARVA mg.						
at 4 weeks.....	0.5	0.6	0.6	0.8	0.8	1.0
at 9 weeks.....	5.1	6.0	5.9	6.1	7.5	7.1

Some gain in average weight occurred when choline was omitted, but the larvae probably obtained some choline as a result of cannibalism.

LIPIDS

The larvae failed to grow in rations like 1 or 3 unless a source of lipid was included. Coconut oil was inactive. Corn oil (saturated

with hydroquinone) or yeast supported growth for a time, but only lipids of animal origin supported continued growth. Petroleum ether extract of liver meal ("liver fat"), Desynon, Oil of Percomorpheum,[6] and cholesterol (Merck) were effective.

In experiments 354 and 355, various amounts of cholesterol, liver fat, and yeast were added to ration 3. Some of the results are summarized in Table VI.

TABLE VII

AMINO ACIDS OF FOUR RATIONS

	AMINO ACIDS	RATION NO.			
		4	5	6	7
		mg./gm.			
dl	α—Alanine Pfanstiehl	.....	8	2	.....
	β—Alanine Smaco	.....	4	2	.....
1 (+)	Arginine HCl Merck	4.86	16	8	10
dl	Aspartic acid Merck	.....	8	2	.....
1 (—)	Cystine Smaco	.....	8	4	.....
1 (+)	Glutamic acid Smaco	.....	16	100	.....
	Glycine Smaco	.....	8	4	.....
1 (+)	Histidine HCl Merck	9.88	16	8	10
1 (—)	Hydroxyproline Merck	.....	8	4	.....
dl	Isoleucine Merck	20.00	32	16	20
1 (—)	Leucine Merck	18.00	32	16	20
1 (+)	Lysine HCl Merck	25.00	32	16	20
dl	Methionine Merck	12.00	16	8	10
dl	Norleucine Merck	.....	8	4	.....
dl	Phenylalanine Merck	14.00	16	16	20
1 (—)	Proline Merck	.....	16	40	.....
dl	Threonine Merck or Smaco	24.00	28	16	20
dl or 1 (—)	Tryptophane Merck or Smaco	4.00	8	4	10
1	Tyrosine Eastman	.....	8	4	.....
dl	Valine Merck	28.00	32	16	20
		159.74	320	290	160

In experiment 345, 22 Aug. 44, eighty newly-hatched larvae were given ration 3, plus 0.5 mg/gm of Merck's cholesterol. 1 Aug. 45, 839 F_1 larvae were recovered from the culture.

Cholesterol seems to be essential to the growth of the *Attagenus* larvae.

AMINO ACIDS

Ten amino acids are necessary for normal growth of rats. If arginine is omitted, rats grow slowly on the remaining nine. A composition (No. 4, Table VII) used in rat experiments (Kinsey and Grant,

[6]Mead Johnson & Co.

1944) was used as a starting point. To the ten essential amino acids, ten others were added. The twenty amino acids were mixed with water, sodium carbonate sufficient to neutralize the hydrochlorides present (Grau and Almquist, 1944), and mineral. Raw corn starch (Argo) was mixed with the partly dissolved amino acids, the mixture dried at 60°C. and powdered. Soluble starch, the B vitamins of ration 3, and liver fat were added one to two days before starting an experiment. The incubator was set at 90°F. and 55±2% R.H. Table VII gives the amino acids used in four mixtures.

Growth was slow in the first mixture prepared. Improved compositions were developed by adding separately one to two per cent of each of the twenty amino acids. In the first trial, arginine was found to be limiting. A new formula containing more arginine was prepared, tested as before, and phenylalanine found to be limiting. As some amino acids were increased in amount, others which seemed injurious or inert were reduced. Ration 5 is one of the improved formulae. Ration 6 gave the most rapid growth obtained to date.

TABLE VIII

EFFECT OF OMITTING ESSENTIAL AMINO ACIDS FROM RATION 5

Number and average weight of larvae surviving at seven weeks. Twenty newly-hatched larvae per test. 90° F., 55±2% R. H. 3 Apr. to 22 May, 45.

AMINO ACID OMITTED	SURVIVORS AT 7 WEEKS	
	Number	Av. Wt.
Arginine	7	0.09
Histidine	3	0.07
Isoleucine	3	<0.04
Leucine	3	<0.04
Lysine	9	0.04
Methionine	4	0.05
Phenylalanine	4	0.05
Threonine	6	0.03
Tryptophane	5	0.04
Valine	5	0.04
None	20	0.40

In experiments 370 and 371, the amino acids were omitted one by one from ration 5. When the amino acids non-essential for rats were omitted, one at a time or all at once, growth continued for at least nine weeks. Table VIII gives the results of omitting the amino acids which are essential for rats.

Ration 7 is a mixture of the ten essential amino acids which I have been unable to improve by adding more of each or by changing the quantity of all. The results of six growth tests made with this mixture appear in Table IX.

TABLE IX

GROWTH AND SURVIVAL OF *Attagenus* LARVAE ON RATION 7

Twenty newly-hatched larvae per test. Number and average weight per larva of survivors. 90° F., 55±2% R. H.

EXPERIMENT	SURVIVORS			
	7 Weeks		9 Weeks	
	Number	Av. Wt. mg.	Number	Av. Wt. mg.
374	20	1.2	20	2.3
375	17	1.0	17	1.7
376	18	1.2	18	2.0
379	11	1.1	.....	.....
	19	1.1	.....	.....
380	18	1.1	16	2.2

In experiment 379, the amino acids of ration 7 were omitted one by one. Table X gives the results.

TABLE X

EFFECT OF OMITTING EACH AMINO ACID FROM RATION 7

Number and average weight per larva of survivors at seven weeks. Twenty newly-hatched larvae per test. 90° F., 55±2% R. H. 27 Aug. to 15 Oct., 45.

AMINO ACID OMITTED	SURVIVORS AT 7 WEEKS	
	Number	Av. Wt. mg.
Arginine	16	0.01
Histidine	9	0.04
Isoleucine	11	0.05
Leucine	3	<0.04
Lysine	9	0.04
Methionine	4	<0.03
Phenylalanine	4	<0.03
Threonine	10	0.02
Tryptophane	6	0.03
Valine	3	<0.04

The better mixtures containing twenty amino acids supported more rapid growth than ration 7. With ration 7, the highest average weight per insect at seven weeks was 1.2 mg. (6 tests). With ration 6, this value was 2.4 mg. (1 test).

CONCLUSIONS

Choline, arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, valine, and cholesterol may be added to the catalog of nutrilites essential for growth of the yellow species of *Attagenus*. Folic acid and biotin are at least essential for normal growth.

SUMMARY

Newly hatched larvae of *Attagenus* grew rapidly in mixtures of (1) purified milk albumin or casein 40–80%, (2) starch, (3) mineral, (4) animal lipids, (5) choline, (6) thiamine, (7) riboflavin, (8) nicotinic acid, (9) pyridoxin, (10) pantothenic acid, (11) folic acid, and (12) biotin. If 4, 5, 6, 7, 8, 9, or 10 was omitted, the insects failed to grow. When 11 was omitted, growth was much slower and mortality considerable. When 12 was omitted, growth was slower up to about eleven weeks. Using milk albumin (Labco Lactalbumin 7 HAAX) as the source of protein, Merck's cholesterol, 0.2 mg./gm., was an adequate source of added lipid. The addition of yeast usually resulted in more rapid growth.

Mixtures of twenty amino acids were substituted for protein by mixing with mineral, sodium carbonate to neutralize hydrochlorides, and water. The partly dissolved amino acids were mixed with raw starch, dried at 60° C., and powdered. The finished rations were prepared by diluting with soluble starch, adding B vitamins in aqueous alcohol, and liver fat at 8 mg./gm.

The ten amino acids essential for maximum growth of the rat were found to be essential for any growth of the *Attagenus* larvae. A mixture of the ten essential amino acids was developed which I was unable to improve. It contains about twice as much arginine as the rat requires. It supported less rapid growth than certain mixtures which contained ten additional amino acids.

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STUDIES ON THE CRANE-FLIES OF MEXICO

PART IX[1]

(Order Diptera, Superfamily Tipuloidea)

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The Tipulidae discussed in this report were received from Mr. Noel L. H. Krauss, collected in Morelos, chiefly in the vicinity of Cuernavaca, and from Dr. Alfons M. Dampf, collected by himself and by Mr. C. C. Plummer. I am very deeply indebted to these entomologists for allowing me to retain the types of the novelties in my personal series of these flies.

Tipula Linnaeus

Tipula (Trichotipula) kraussi sp. n.

Thorax almost uniformly polished reddish brown, abdomen entirely polished black; antennae elongate, bicolored; halteres and legs uniformly black; wings with a very strong blackish tinge; petiole of cell M_1 short to virtually lacking; male hypopygium with the posterior border of tergite very gently and broadly emarginate; inner dististyle broad.

Male.—Length about 10.5–11 mm.; wing, 11–12 mm.; antenna about 7 mm.

Frontal prolongation of head dark chestnut brown, polished; nasus elongate, black; palpi black. Antennae (male) elongate, more than one-half the wing; basal three segments obscure yellow, succeeding ones bicolored, the basal enlargement black, the stems abruptly yellow, the bicolored nature persisting to the terminal segment; basal enlargements oval, relatively abrupt; verticils shorter than the segments, the latter with a dense erect white pubescence. Head dark polished reddish chestnut; vertical tubercle very low.

Thorax almost uniformly polished reddish brown, the dorsopleural membrane darker brown; vestiture of the praescutal interspaces weak and sparse. Halteres black throughout. Legs with the coxae dark reddish, the posterior and middle pairs even more blackened, this color likewise involving the meral region; apex of middle coxae reddish; fore trochanter dark reddish, the remaining pairs even darker; remainder of legs uniformly blackened; claws (male) very small, simple. Wings with a very strong blackish tinge, the prearcular and costal fields even more saturated; cells *R*, *M*, *Cu* and *1st A* with paler central streaks and, in cases, the outer medial cells somewhat paler; stigma scarcely darker than the ground; obliterative areas before stigma and across base of cell *1st* M_2 very restricted; no post-stigmal brightening; veins brown, those of the outer medial field more delicate. No squamal setae but the

[1]The preceding part under this general title appeared in these Annals (Vol. XXXIX, 119–139, 1946). Contribution from the Entomological Laboratory, Massachusetts State College.

margin distad of the squama with several setae of unusual length; outer veins of radial and medial fields with trichia. Venation: *Rs* about one-third to one-fourth longer than *m-cu; R_{1+2}* entire or with the extreme tip atrophied; petiole of cell M_1 very short to virtually lacking, not exceeding *m* in length; cell *2nd A* wide.

Abdomen, including hypopygium, polished black. Male hypopygium with the tergite transverse, the caudal margin very broadly and gently emarginate, at the midregion beneath with a rounded lobe; lateral lobes very low, with abundant short setae and a few longer ones. Outer dististyle a small dusky cylindrical lobe, with long black setae. Inner dististyle broad, the beak stout; lower beak more slender, separated from the beak by a broad notch; outer basal lobe small, triangular in outline. Appendage of ninth sternite appearing as an oval darkened lobe on either side, tipped with a few very long black setae. Aedeagus small; gonapophyses apparently lacking or reduced to microscopic rudiments. Eighth sternite narrowed posteriorly, the caudal border broadly pale and membranous, with dense elongate setae, the edge gently emarginate.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 3, 1944 (Krauss). *Paratopotype*, 1 ♂.

I am pleased to name this interesting fly for the collector, Mr. Noel L. H. Krauss, to whom I am indebted for several interesting Tipulidae from Mexico and Hawaii. It is entirely different from all other regional members of the genus, in its general appearance suggesting certain members of the subgenus *Microtipula* Alexander. I feel that the present reference to the subgenus *Trichotipula* Alexander is correct but the species must be held to be somewhat aberrant. It may be noted that in the Nearctic fauna there are several members of the subgenus that lack macrotrichia in the wing cells, as in the present fly. In its general appearance the species somewhat suggests members of the genus *Nephrotoma* Meigen.

Tipula (Trichotipula) vultuosa sp. n.

General coloration of body polished orange-yellow; anterior vertex with a darkened central line; femora yellow, the tips narrowly blackened, claws of male toothed; wings with a strong brownish yellow tinge, the veins dark and conspicuous; relatively numerous macrotrichia in cells R_3 to *2nd* M_2, inclusive, more abundant in the radial cells; intermediate abdominal tergites trilineate with black, the median stripe broad and conspicuous, the lateral pair narrower; male hypopygium with the outer dististyle narrow, approximately four times as long as broad across base; rostral prolongation of inner dististyle with abundant pale setae.

Male.—Length about 13 mm.; wing, 13 mm.; antennae about 4 mm.

Frontal prolongation of head relatively short, less than the remainder of head, yellow with a black line on either side; nasus slender; palpi with basal three segments brown, the terminal one more yellowed. Antenna (male) moderately long; scape and pedicel yellow, basal two flagellar segments obscure yellow, the succeeding ones weakly bicolored, the brown basal enlargements slightly darker than the more brownish

yellow stems; longest verticils exceeding the segments in length. Head orange-yellow, polished; anterior vertex broad, with a brown median stripe; vertical tubercle low and simple.

Pronotum orange-yellow. Mesonotum almost uniformly orange-yellow or fulvous, the surface polished, the lateral borders of praescutum restrictedly yellow; a very small brown marginal spot at the humeral region; setae of notum pale, sparse and inconspicuous. Pleura fulvous yellow, the dorsopleural region and pleurotergite paler. Halteres with stem obscure yellow, brighter at base, knob somewhat more darkened. Legs with the coxae fulvous yellow; trochanters testaceous yellow; femora yellow, the tips rather narrowly but conspicuously blackened, the amount subequal on all legs; tibiae obscure yellow, the tips narrowly darkened; tarsi black; claws (male) toothed. Wings with a strong brownish yellow tinge, the restricted prearcular field, costal border and outer radial field more infuscated; stigma scarcely differentiated from the ground; veins dark brown, conspicuous, those in the prearcular and costal fields more brownish yellow. Sparse macrotrichia in outer ends of cells R_3 to *2nd* M_2, inclusive, fewest in the last-named cell, much more numerous in the radial cells where they occupy more than the outer third of the cells; stigmal trichia very sparse, only two or three. Venation: *Rs* shorter than *m-cu* and about one-fourth longer than R_{2+3}; R_{1+2} preserved; petiole of cell M_1 short, a trifle longer than *m;* basal section of vein M_4 perpendicular, more than one-half as long as vein M_{3+4}; cell *2nd A* relatively broad.

Abdomen yellow, tergites two to six with a very conspicuous black central stripe or area, narrowly broken at the posterior margin, becoming more expanded on the outer segments; lateral borders of the same segments with narrower lines, the corresponding dorsal edge of the sternites less conspicuously blackened; remainder of abdomen, including hypopygium, yellow. Male hypopygium with the caudal margin of the ninth tergite with a deep V-shaped notch, the lobes obtuse, with the usual erect spinous setae, the retrorse group at the apex of lobe unusually numerous and having the same general appearance as the marginal series. Outer dististyle narrow, a little expanded on proximal half, at this point about one-fourth the length; setae long and numerous, reddish brown. Inner dististyle with the rostral portion elongate, about as long as the basal enlarged part of style, the apex suddenly narrowed; prolongation provided with abundant long pale delicate setae; setae of body of style back from the rostrum shorter and stouter, black; on posterior portion of style, in the region of the usual outer basal lobe, with a dense grouping of reddish bristles; what appears to represent the lower beak lies unusually basad, appearing as a blackened toothlike structure, with several setae on its basal half. Ninth sternite not produced. Eighth sternite with the pale membranous posterior margin gently convex in outline.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, September 5, 1944 (Krauss).

The most similar species include *Tipula* (*Trichotipula*) *aplecta* Alexander and *T.* (*T.*) *religiosa* Alexander, which have the hypopygial characters quite distinct, including the tergite, both dististyles, and the eighth sternite. Comparison with the species next described, *T.* (*T.*) *uxoria* sp. n., should be noted.

Tipula (Trichotipula) uxoria sp. n.

Allied to *vultuosa;* general coloration polished light castaneous, the praescutum variegated with darker, including very conspicuous blackened lateral spots in the humeral region and at the lateral ends of the transverse suture; fore femora with more than the outer half blackened; wings with a strong brownish yellow suffusion, cell *C* more infuscated; stigma short-oval, brown; restricted macrotrichia in outer ends of cells R_5 and M_1; abdomen orange, tergites with broken black areas on the intermediate segments.

Female.—Length about 9.5–11 mm.; wing, 11–12 mm.

Frontal prolongation of head polished yellow, narrowly darkened medially above, including the conspicuous nasus; palpi with first segment obscure brownish yellow, succeeding two segments a trifle darker; terminal segment obscure orange. Antennae with scape and pedicel light yellow; remainder of organ broken. Head with the vertical tubercle orange, high, conspicuously emarginate medially; posterior portion of vertex more infuscated, sending a darkened extension onto the vertical tubercle; occiput and genae somewhat paler.

Pronotum very pale yellow. Mesonotal praescutum polished light castaneous, variegated with darker, including four spots on the cephalic portion, representing the anterior ends of the usual four stripes; in addition, an even more conspicuous blackened spot in the humeral region at the margin, with a somewhat similar one at the end of the transverse suture; lateral praescutal border elsewhere more yellowed; remainder of notum similarly light castaneous or reddish orange, unpatterned. Pleura polished yellow, the dorsopleural membrane even paler. Halteres yellow. Legs with the coxae and trochanters yellow; fore femora yellow basally, with more than the outer half blackened; remaining femora yellow, the tips narrowly but conspicuously blackened; all tibiae obscure yellow, the tips narrowly blackened; tarsi black, the proximal ends of the basitarsi vaguely more brightened. Wings with a strong brownish yellow suffusion, cell *C* more infuscated, cell *Sc* light yellow; prearcular field brownish yellow; stigma small, short-oval, brown; wing-tip narrowly and vaguely infuscated; cord and outer portion of vein *Cu* narrowly seamed with brown, more evident on *m-cu* and *Cu;* Anal cells in large part slightly more infuscated, cell *1st A* with a yellowish streak adjoining vein *2nd A;* veins dark brown or brownish black, yellow in the more brightened fields. Sparse macrotrichia in outer ends of cells R_5 and M_{1+2}, especially the former. Venation: *Rs* shorter than *m-cu;* petiole of cell M_1 very variable in length, in the type about two and one-half times as long as *m*, in the paratype much shorter than *m*.

Abdomen orange yellow, the tergites with three interrupted black or brownish black stripes, the middorsal series larger but broken into oval spots, becoming obsolete on segments six or seven.

HABITAT: Mexico (Morelos). *Holotype*, ♀, Cuernavaca, altitude 5000 feet, August 14, 1944 (Krauss). *Paratopotype*, 1 ♀, August 24, 1944.

Generally similar to *Tipula* (*Trichotipula*) *vultuosa* sp. n., differing in important details of body-coloration and trichiation of the wings, especially the pattern of the thorax and the extensively blackened fore

femora, together with the restricted macrotrichia in the wing cells. Most of the described Mexican species of the subgenus bear a superficial resemblance to species of *Nephrotoma* Meigen.

Tipula (Lunatipula) dampfiana sp. n.

General coloration of mesonotal praescutum gray with four slightly differentiated darker gray stripes; posterior sclerites of notum and the pleura pale; wings with a brownish yellow tinge, the obliterative band before cord relatively inconspicuous; abdomen yellow, the tergites with very broad brownish black, nearly lateral stripes; male hypopygium with the tergal lobes narrow; inner dististyle with the posterior crest short and obtuse; outer basal lobe short and stout.

Male.—Length about 14 mm.; wing, 14.5 mm.; antenna about 4.5 mm.

Frontal prolongation of head buffy; nasus short and stout; first segment of palpus obscure yellow, the remainder brownish black. Antennae of moderate length, outer segments broken; first three segments yellow, the succeeding ones bicolored, the basal enlargement darker, stem yellow; on about the fourth and succeeding segments the stems more brownish yellow, outer segments uniformly blackened; flagellar segments moderately incised, longer than the verticils. Front and extreme anterior vertex pale, remainder of dorsum dark brownish gray throughout.

Pronotum infuscated. Mesonotal praescutum gray with four slightly differentiated darker gray stripes, the lateral praescutal borders broadly paler gray; scutal lobes dark gray, the median region very restrictedly obscure yellow; scutellum and mediotergite pale, pruinose. Pleura and pleurotergite chiefly pale yellow pollinose (the more cephalic pleurites destroyed by pinning). Halteres with stem obscure yellow, knob infuscated. Legs with the coxae yellow pollinose; trochanters yellow; femora obscure yellow, the tips rather narrowly dark brown; tibiae and basitarsi obscure yellow, the tips even more restrictedly darkened; outer tarsal segments more infuscated; claws (male) simple. Wings with a strong brownish yellow tinge, cell *Sc* clearer yellow; stigma pale brown, relatively inconspicuous, its proximal end paler; obliterative area before cord restricted and inconspicuous, appearing as an isolated prestigmal spot and a larger area that centers at cell *1st* M_2, more or less interrupted by darkened seams to the medial veins; veins brown, yellow in the brighter areas. Squama with relatively few bristles. Venation: *Rs* slightly less than twice *m-cu;* R_{1+2} entire but with its distal half paler and without trichia; petiole of cell M_1 longer than *m;* basal section of M_{3+4} subequal in length to *m*.

Abdomen yellow, the tergites with very broad and conspicuous brownish black stripes that are almost lateral in position, the pale borders being very narrow; basal sternites yellow; subterminal segments blackened, forming a broad ring; hypopygium more brownish yellow. Male hypopygium much as in *abscissa;* tergite with lateral lobes narrow but stouter than in *abscissa*, separated by a broad, gently convex median area. Inner dististyle with the posterior crest short and obtuse, not long-produced backward, as in *abscissa;* beak very short and blunt; outer basal lobe much shorter and stouter than in *abscissa*.

HABITAT: Mexico (Mexico). ***Holotype***, ♂, Slopes of Mount Telapón, Valle de Mexico, altitude 2100–3500 meters, October 2, 1938 (Dampf); M. F. 7112.

I take particular pleasure in naming this species for my long-time friend and co-worker, Dr. Alfons M. Dampf. The fly is closely related to ***Tipula*** (***Lunatipula***) ***abscissa*** sp. n., differing in the pattern of the body and wings and, especially, in the structure of the male hypopygium, particularly the tergite and inner dististyle.

Tipula (Lunatipula) abscissa sp. n.

General coloration of mesonotum obscure yellow with brown markings; praescutal stripes four, entire; antennae strongly bicolored; thoracic pleura unpatterned; femora yellow, the tips narrowly brownish black; wings with a strong brownish tinge, with a continuous, very conspicuous obliterative area before the cord; abdominal tergites yellow, with very conspicuous sublateral black stripes that become more extensive and finally confluent on the outer segments; male hypopygium with the ninth tergite having the caudal border produced into a ventral polished plate, the lateral lobes terminating in small compressed blades; eighth sternite with conspicuous pencils and groups of setae.

Male.—Length about 13–14 mm.; wing, 15.5–16 mm.; antenna about 5 mm.

Frontal prolongation of head above yellow, slightly infuscated on sides; nasus distinct; palpi with proximal three segments obscure yellow, the terminal one brownish black. Antennae with basal three segments yellow, succeeding segments strongly bicolored, yellow, with black basal swellings, only the outer two or three segments uniformly darkened; basal swellings very small to scarcely thicker than the outer portion of segment; longest verticils somewhat exceeding the segments. Head with anterior portion buffy yellow, the posterior portion, including a central prolongation on anterior vertex, more grayish brown; orbits narrowly light gray; anterior vertex relatively narrow, about twice the diameter of scape; vertical tubercle not developed.

Pronotum obscure yellow, variegated with more brownish spots. Mesonotal praescutum obscure yellow, with four entire brown stripes, the intermediate pair more divergent at their anterior ends, leaving an extensive area of the ground, this pale stripe broad and conspicuous throughout its length; scutum with lobes light gray, extensively marked with brown, median area lighter brown; posterior sclerites of notum lighter gray, the scutellum with a vague darker area; mediotergite with an extensive sublateral brown area on either side, not reaching the sides of the sclerite; dorsal portion of pleurotergite infuscated. Pleura grayish yellow, unpatterned; dorsopleural membrane weakly infuscated. Halteres with stem obscure yellow, knob infuscated. Legs with the coxae and trochanters yellow; femora and tibiae yellow, the tips narrowly brownish black, the amount subequal on all legs; tarsi with basal two segments obscure yellow, the tips more darkened; outer tarsal segments brownish black; claws (male) simple. Wings with a strong brownish tinge, the prearcular and costal fields slightly more yellowed;

stigma relatively small, brown, the proximal end more yellowed; a continuous conspicuous whitish obliterative area extending from before the stigma across outer end of cell *R*, basal half of *1st* M_2 and into cell M_3; no post-stigmal brightening; veins brownish yellow, still brighter in the more yellowed areas. Venation: *Rs* about one-fourth longer than *m-cu;* R_{1+2} entire; petiole of cell M_1 and *m* subequal; *m-cu* on M_4 close to fork of M_{3+4}; cell *2nd A* broad.

Abdominal tergites reddish yellow with a very conspicuous sublateral black longitudinal stripe beginning near base of tergite two, narrowly interrupted at posterior borders of segments, becoming even more extensive on outer segments; lateral tergal borders very narrowly pale; basal sternites yellow, outer segments more infuscated and finally dark brown, including the hypopygium. Male hypopygium with the ninth tergite having a broad and deep dorsal furrow, the caudal border shallowly emarginate but with a more ventral shiny portion whose margin is convexly rounded; lateral lobes terminating in small compressed-flattened blades or points. Ninth sternite with the appendage low, simple, with long yellow setae. Outer dististyle dusky, slightly widened at near midlength. Inner dististyle with beak compressed-flattened; dorsal crest arising abruptly above the beak, setae sparse; posterior crest produced backward into a long pale blade, its margin microscopically erose; lower beak blackened, subtriangular; outer basal lobe relatively small, erect, provided with numerous long yellow setae. Aedeagus not much expanded at apex, produced into a small spinous point on either side. Eighth sternite with the lateral lobes low, tipped with compact pencils of long reddish setae that are directed inward and become decussate, at bases of lobes with more abundant smaller setae; lying more ventrad and nearer the midline on either side with a transverse row or brush of long golden setae, the outer portions bent inward to the midline.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Tepoztlan, September 4, 1944 (Krauss). *Paratopotype*, ♂.

The present fly is most nearly allied to *Tipula* (*Lunatipula*) *dampfiana* sp. n. and comparisons have been given under the account of that species. In the structure of the male hypopygium, especially of the tergite, these two species suggest forms such as *T.* (*L.*) *incisa* Doane but the relationship is not close.

Limonia Meigen

Limonia (**Dicranomyia**) **perserena** sp. n.

General coloration of the entire body pale greenish yellow or white; halteres entirely pale; legs whitened; wings hyaline, the stigma very pale brown; a vague darkening over the cord; cell M_2 open by the atrophy of the basal section of M_3, cell *2nd* M_2 subequal in length to or shorter than its petiole; *m-cu* at fork of *M;* cell *2nd A* wide; male hypopygium with the rostral prolongation of ventral dististyle short, the two spines stout and spikelike.

Male.—Length about 5–6 mm.; wing, 6–7.5 mm.

Rostrum moderately long, testaceous yellow; palpi pale. Antennae with scape yellow, pedicel brown, flagellum somewhat paler brown;

flagellar segments oval. Head above yellow, even more orange on central part of vertex; anterior vertex broad, nearly two and one-half times the diameter of scape.

Pronotum yellow. Mesonotum pale greenish white on anterior portion of praescutum, the posterior two-thirds of the latter and the remainder of notum a very little darker, unpatterned. Pleura yellow. Halteres entirely pale. Legs whitened, only the outer tarsal segments a trifle darker. Wings hyaline, the prearcular and costal regions a trifle more yellowed; stigma short-oval, very pale brown; a similarly vague darkening over the cord; veins yellow, the cord a trifle more darkened. Venation: *Sc* short, Sc_1 ending a distance before origin of *Rs* about equal to from one-fourth to one-sixth the length of the latter, Sc_2 apparently atrophied; free tip of Sc_2 and R_2 in transverse alignment; cell M_2 open by the atrophy of basal section of M_3; cell *2nd* M_2 subequal in length to or shorter than its petiole; *m-cu* at fork of *M;* cell *2nd A* wide.

Abdomen obscure yellow, including the hypopygium. Male hypopygium with the posterior border of tergite emarginate, the lobes broad, with strong setae. Basistyle with the ventromesal lobe large, simple. Dorsal dististyle a strongly curved hook, the outer third rather strongly narrowed. Ventral dististyle large and fleshy, its area at least three times that of the basistyle; rostral prolongation short and stout, at apex even further produced into a more flattened dark-colored flange; the two rostral spines are placed close together near the base of prolongation; stout and spikelike, their tips obliquely acute. Gonapophysis with mesal-apical lobe erect, the apex bent slightly laterad.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Tepoztlan, September 4, 1944 (Krauss). *Paratypes*, 2 ♂♂, Cuernavaca, October, 1944, March, 1945 (Krauss).

Limonia (Dicranomyia) perserena is readily distinguished from all other regional members of the subgenus by the venation, especially the cell M_2 open by the atrophy of the basal section of M_3, a very rare condition in the subgenus.

Limonia (Geranomyia) disparilis sp. n.

General coloration of mesonotum dull black, the praescutum almost covered by blackened stripes; rostrum relatively short, black throughout; wings with a strong dusky tinge, unmarked except for the oval, darker brown stigma; *Sc* short; abdomen, including hypopygium, brownish black; male hypopygium with two rostral spines on ventral dististyle, these very unequal in size, the more basal one largest, placed at the base of prolongation on the face of the style itself; second spine reduced to a seta, lying more distad at the base of the major spine; apex of prolongation obtusely rounded.

Male.—Length, excluding rostrum, about 4.5 mm.; wing, 5 mm.; rostrum about 1.8 mm.

Rostrum relatively short, black throughout; palpi black. Antennae black throughout; flagellar segments oval, the outer ones gradually decreasing in size; verticils short. Head black.

Mesonotum chiefly dull black, the praescutum almost covered by blackened stripes, reducing the paler ground to humeral areas. Pleura

black, slightly plumbeous. Halteres black, the base of stem yellow. Legs with coxae brownish black, the posterior pair paler; trochanters obscure yellow; remainder of legs broken. Wings with a strong dusky tinge, cell *Sc* even darker; stigma oval, darker brown; veins brown. Venation: *Sc* short, Sc_1 ending just beyond the origin of *Rs*, Sc_2 at its tip; *m-cu* just before the fork of *M;* cell *2nd A* of moderate width.

Abdomen, including hypopygium, brownish black. Male hypopygium with the tergite transverse, the caudal margin gently emarginate. Ventral dististyle relatively small, the rostral prolongation moderately long, its apex obtusely rounded; two rostral spines of very different sizes, the more basal one largest, placed on the face of style at base of prolongation, arising from a conspicuous cylindrical tubercle, the spine short and straight; second spine reduced to a slender seta, from a correspondingly tiny globular tubercle, placed close to the base of the outer face of the major tubercle; prolongation beyond the outer spine exceeding in length the spine itself. Gonapophysis with mesal-apical lobe relatively broad, narrowed to a spinous apical point, the lateral margin vaguely toothed.

HABITAT: Mexico (Chiapas). *Holotype*, ♂, Finca Victoria, altitude 900 meters, June 29, 1935 (Dampf); M. F. 4709.

The present fly is readily told by the structure of the male hypopygium. In this latter respect it is most similar to *Limonia* (*Geranomyia*) *versuta* Alexander, ranging from southern Mexico to Colombia, but differs in all details. The general appearance of the two flies is quite dissimilar and it does not appear that they are closely allied.

Orimarga Osten Sacken

Orimarga (Orimarga) tartarus sp. n.

General coloration of thorax brownish gray, the praescutal stripes ill-delimited; antennae and legs blackened; wings with a strong blackish tinge, the prearcular and costal fields whitened; vein R_{1+2} elongate, nearly three times R_{2+3}; R_1 beyond the free tip of Sc_2 about one-half longer than R_{2+3}; cell M_3 longer than its petiole; *m-cu* about twice its length before the fork of *M;* cell *2nd A* greatly widened on its basal portion; male hypopygium with the gonapophyses appearing as short straight spikes.

Male.—Length about 5.5–6 mm.; wing, 5.5–6 mm.

Female.—Length about 5.5–6.5 mm.; wing, 6–7 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments short-oval. Head above brownish gray, the front light silvery gray; anterior vertex relatively broad, about three times the diameter of scape.

Pronotum dark brown, sparsely pruinose. Mesonotal praescutum brownish gray with four ill-delimited darker brown stripes, the interspaces very obscured, the lateral praescutal borders broadly light gray; posterior sclerites of notum gray, the scutal lobes darkened. Pleura gray, the ventral sternopleurite more blackened; a more or less evident blackened stripe lying more dorsally. Halteres with stem brown, narrowly yellow at base, knob blackened. Legs with the fore and middle coxae darkened, pruinose, posterior coxae conspicuously yellow; tro-

chanters darkened; remainder of legs dark brown or brownish black. Wings with a strong blackish tinge, the prearcular and costal fields whitish; outer end of cell R_5 slightly whitened; veins dark brown. Outer veins of wing, including both radial and medial fields, with relatively abundant macrotrichia. Venation: Sc_1 ending about opposite two-fifths the length of *Rs*, Sc_2 a short distance from its tip; R_{1+2} elongate, nearly three times R_{2+3}; free tip of Sc_2 preserved; R_1 about one-half longer than R_{2+3}; inner end of cell R_3 only slightly arcuated, about on a level with cell M_2; cell M_3 longer than its petiole; *m-cu* oblique, about twice its length before the fork of *M;* cell *2nd A* greatly widened on its basal portion.

Abdomen, including hypopygium, brownish black to black. Male hypopygium with the basistyle unmodified, the setae simple, much more numerous on mesal face. Outer dististyle long and slender, gradually narrowed to the acute tip. Inner dististyle about as long, with a single row of strong setae down the face, near base of style with a stout lobe bearing six to eight strong setae. Gonapophysis a short straight spike, the tip blunt.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, May 1945 (Krauss). *Allotopotype*, ♀, pinned with type. *Paratopotypes*, numerous ♂ ♀, August 1944–May 1945 (Krauss).

In its somewhat peculiar venation, the present fly suggests species such as *Orimarga* (*Orimarga*) *excessiva* Alexander and *O.* (*O.*) *saturnina* Alexander, yet differs in the proportions of the radial elements, as described. It further differs from all other generally similar regional forms by the very strongly darkened wings.

Orimarga (Orimarga) subtartarus sp. n.

Male.—Length about 5 mm.; wing, 4.5–5.5 mm.

Female.—Length about 6 mm.; wing, 5.2 mm.

Very similar to *tartarus*, differing especially in color and in the venational details. Legs paler, the femoral tips narrowly more darkened. Wings brownish gray, not conspicuously blackened, as in *tartarus*. Venation: R_{1+2} shorter, less than twice R_{2+3}; free tip of Sc_2 opposite the fork of *Rs; m-cu* only a little more than its own length before the fork of *M*.

HABITAT: Mexico (Jalisco). *Holotype*, ♂, Tequila, altitude 3900 feet, along an irrigation canal, July 28, 1934 (Dampf); M. F. 3568. *Allotopotype*, ♀, pinned with type. *Paratopotype*, 1 ♂.

Oxydiscus de Meijere

Oxydiscus (Oxydiscus) morelosensis sp. n.

Dark chestnut brown; halteres whitened; wings with a weak brownish tinge, restrictedly patterned with darker brown; macrotrichia of wing cells relatively numerous.

Female.—Length about 5 mm.; wing, 5 mm.

Rostrum and palpi black. Antennae black throughout; outer flagellar segments oval. Head dark brown.

Thoracic dorsum almost uniformly dark chestnut brown, without

pattern; scutellum a little darker behind. Pleura somewhat darker brown, especially on the ventral portion. Halteres whitened. Legs with the coxae yellow, the fore pair somewhat darker; trochanters obscure yellow; remainder of legs broken. Wings with a weak brownish tinge, the prearcular and costal fields a little paler; a restricted brown pattern, including very narrow seams at origin of *Rs*, Sc_2, cord, outer end of cell *1st* M_2 and over R_2, the remainder of the stigmal area paler brown but extensive; veins pale brown, a little darker in the clouded portions. Macrotrichia in outer wing cells, including several in cell R_2 beyond the stigma, extending to cell *1st A*, becoming more sparse in the posterior cells. Venation: Sc_1 ending a short distance beyond the fork of *Rs*, Sc_2 some distance from its tip; *Rs* obliquely angulated at origin; cell R_3 deeper than in *oaxacensis;* cell M_1 shorter and with the enclosing branches more divergent; *m-cu* more than its own length beyond the fork of *M*.

Abdominal tergites brown, the posterior borders of the outer segments narrowly paler; sternites obscure brownish yellow.

HABITAT: Mexico (Morelos). *Holotype*, ♀, Cuernavaca, altitude 5000 feet, August 14, 1944 (Krauss).

The most similar species and the only other described regional one having patterned wings is *Oxydiscus* (*Oxydiscus*) *oaxacensis* Alexander, which has the wing pattern heavier and shows slight venational differences, as indicated above. In this latter fly, the macrotrichia of the cells are somewhat less numerous, as shown by the lack of poststigmal setae in cell R_2.

Gnophomyia Osten Sacken

Gnophomyia (Gnophomyia) subobliterata sp. n.

Size medium (wing 6 mm. or less); general coloration of mesonotal praescutum and scutal lobes blackened, the surface sparsely pruinose, the humeral and lateral portions of praescutum yellow; thoracic pleura with a more or less entire brown longitudinal stripe; legs brownish yellow, outer tarsal segments blackened; wings with a weak brownish tinge, stigma lacking; outer radial veins strongly decurved at tip, cell R_2 at margin very extensive; vein R_2 atrophied or its position barely indicated; *m-cu* at about two-thirds its own length beyond the fork of *M;* male hypopygium with the inner dististyle black, its lower margin with three or four very long and powerful setae; phallosome with the upper plate conspicuously emarginate to produce two blackened lobes.

Male.—Length about 5.5 mm.; wing, 5.8 mm.; antenna about 1.5 mm.

Female.—Length about 6 mm.; wing, 6 mm.

Rostrum obscure yellow; palpi brown. Antennae with scape and pedicel light brown to brown, flagellum black; flagellar segments elongate, the longest verticils exceeding the segments. Head gray.

Pronotum light yellow above, more darkened on sides. Mesonotal praescutum and scutum blackened, the surface sparsely pruinose, the humeral and lateral portions obscure yellow; vicinity of the suture more or less reddened; scutellum yellow, weakly darkened basally; mediotergite brownish black, the cephalic portion vaguely more brightened. Pleura and pleurotergite obscure yellow, with a more or less distinct dark brown dorsal stripe, more nearly complete in female, in male more

broken behind by the pale pleurotergite. Halteres blackened, base of stem yellow. Legs with the coxae and trochanters yellow, fore coxae weakly more darkened; remainder of legs obscure brownish yellow, outer tarsal segments blackened. Wings with a weak brownish tinge, the extreme base more yellowed; stigma lacking; veins brown, the prearcular ones brighter. Venation: Outer branches of *Rs* strongly decurved, cell R_2 at margin thus being very extensive; vein R_2 atrophied or barely indicated, placed just beyond the fork of R_{2+3+4}; *r-m* at fork of *M;* cell *1st* M_2 elongate, a little longer than vein M_4; *m-cu* about two-thirds its own length beyond the fork of *M*.

Abdominal tergites dark brown, the pleural membrane and hypopygium more yellowed; ovipositor with cerci compressed, yellow, the tips narrowed and slightly more darkened; cerci hairy to the tips. Male hypopygium having the basistyle with a small pale subglobular lobule on mesal face at base. Outer dististyle glabrous, relatively slender, gradually narrowed outwardly, the tip narrowly obtuse, both base and apex narrowly infuscated, the intermediate portion pale. Inner dististyle much shorter, the base enlarged, the free outer portion relatively slender, the tip very obtuse to slightly dilated; lower or ventral margin of style near base of free portion with three or four setae of unusual length, the longest only a little shorter than the free portion alone. Phallosome with the upper plate conspicuously emarginate to produce two blackened lobes; the lower plate with a few microscopic blackened points that show in the emargination.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Tepoztlan, September 4, 1944 (Krauss). *Allotopotype*, ♀, pinned with the type.

From other generally similar regional species that have the venation of the radial field somewhat as in the present fly, especially ***Gnophomyia (Gnophomyia) acricula*** Alexander, this insect is most readily separated by the distinctive hypopygium, including both dististyles and the phallosome.

Gnophomyia (Gnophomyia) subarcuata sp. n.

Allied to *arcuata;* general coloration of head and thorax dark plumbeous gray; antennae black throughout; halteres brownish black, the apex of knob very slightly reddened; wings hyaline, stigma very slightly indicated; vein R_{2+3+4} moderately arcuated, R_2 subequal to or somewhat longer than R_{3+4}; cerci elongate, with scattered coarse setae.

Female.—Length about 7 mm.; wing, 5.8 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments oval; verticils relatively inconspicuous. Head plumbeous gray.

Pronotum dark gray, the lateral portions of praescutum restrictedly obscure yellow. Mesonotum dark plumbeous gray, the posterior sclerites and the pleura clearer gray. Halteres brownish black, the apex of knob very slightly reddened. Legs with coxae gray pruinose; remainder of legs black. Wings hyaline, stigma barely darkened; veins dark brown. Venation: Sc_1 ending about opposite five-sixths *Rs;* R_{2+3+4} moderately arcuated, conspicuously less so than in *arcuata;* R_2 subequal to or a little longer than R_{3+4}; vein R_3 shorter than in *arcuata;* cell *1st* M_2 strongly narrowed at proximal end; *m-cu* close to the fork of *M*.

Abdomen brownish black. Cerci elongate, fleshy, the tips notched; surface with scattered coarse setae, including some of large size. The emarginate tips of the cerci appear to represent a normal condition.

HABITAT: Mexico (Chiapas). *Holotype*, ♀, Finca Vergel, altitude 800 meters, May 23, 1935 (Dampf); M. F. 4268.

Gnophomyia (*Gnophomyia*) *subarcuata* is allied to species such as *G.* (*G.*) *arcuata* Alexander or *G.* (*G.*) *diazi* Alexander, differing especially in details of venation and in the structure of the ovipositor.

Gonomyia Meigen

Gonomyia (**Lipophleps**) **rastriformis** sp. n.

Belongs to the *cinerea* group; all femora differently patterned; wings with cell M_2 open by the atrophy of basal section of M_3; male hypopygium with the outer dististyle an unusually stout simple rod; intermediate style widely dilated beyond midlength, the margin of the flange darkened and microscopically serrulate; inner style a clavate pale lobe, its lower edge remote from the apex bearing a small mace-like structure that terminates in several small points.

Male.—Length about 4 mm.; wing, 4.2 mm.

Rostrum dark brown; palpi black. Antennae with the basal segments yellow above, more infuscated beneath; basal flagellar segments pale, the outer ones passing into brown. Head with the center of vertex brownish gray, the remainder conspicuously yellow.

Pronotum and pretergites yellow, the scutum slightly darker medially. Mesonotum brownish gray, the central region of scutum more orange, with a narrow darker median line; posterior border of scutellum, broad lateral borders of mediotergite and the anapleurotergite yellow, the katapleurotergite infuscated; humeral and lateral portions of praescutum obscure yellow. Pleura obscure brownish yellow dorsally, the ventral half striped longitudinally with darker brown and yellow, including a very narrow longitudinally more dorsal stripe, extending from behind the fore coxae to the base of abdomen, passing through the root of the halteres; ventral sternopleurite and meral region broadly paler brown. Halteres yellow, the knob weakly darkened. Legs with the coxae yellow, the bases of the fore and middle pairs narrowly infuscated; trochanters yellow; all legs differently patterned; fore femora black, the extreme bases paler; tibiae white, the bases narrowly, the tips a little more extensively blackened; tarsi brownish black, the basitarsi immediately beyond origin obscure yellow; middle femora yellow, the tips rather narrowly blackened, including about the distal seventh; remainder of middle legs about as on fore pair; posterior femora obscure yellow, with a narrow subterminal pale brown ring, preceded by a vaguely brighter yellow area; tibiae white, with an exceedingly narrow subterminal brown ring, the extreme base vaguely darkened; basitarsi with about the proximal two-thirds yellow, the remainder of tarsi black. Wings with a brownish gray ground, the costal border more whitened, expanded in the vicinity of the darker brown stigma to form conspicuous prestigmal and poststigmal brightenings; a vague darkening along cord, indicated by a deepening in color of the veins; remaining veins paler brown, those in the whitened

fields white or pale yellow. Venation: Sc_1 ending a distance before origin of *Rs* nearly as long as this latter vein alone, Sc_2 a short distance from the tip; cell M_2 open by the atrophy of basal section of M_3; *m-cu* close to the fork of *M*.

Abdomen brown, the posterior borders of the segments pale, including two pale spots, narrowly separated from one another by a median dark projection; hypopygium chiefly darkened. Male hypopygium with the outer dististyle an unusually long and strong slender rod, approximately four-fifths as long as the major second style, the tip acute and narrowly blackened, microscopically roughened; intermediate style largest, appearing as a flattened blade, bearing on inner edge a blackened microscopic scabrous spine or arm; beyond this arm the style is widely dilated, the flange narrowly darkened and microscopically serrulate on margin; inner style or branch a chiefly pale clavate lobe, provided with numerous long strong setae; on lower edge, remote from the apex, with a blackened mace-like structure that terminates in several small points.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 24, 1944 (Krauss).

The most similar described species are *Gonomyia* (*Lipophleps*) *helophila* Alexander and *G.* (*L.*) *monacantha* Alexander, which differ very conspicuously in the structure of the male hypopygium.

Gonomyia (Gonomyia) stellata sp. n.

Allied to *mexicana:* general coloration of mesonotum dark brown, the pleura but slightly patterned; wings with a weak dusky tinge, the prearcular and costal fields more whitened; *Rs* a little shorter than R_{2+3+4}; *m-cu* at near two-fifths the length of cell *1st* M_2; male hypopygium with the outer blade of dististyle blackened, the outer margin with about four strong spines, additional to the longer terminal one, with a longer blackened rod in the axil of the pale inner lobe; apophyses paired, elongate, slender, each bearing a long branch at near two-thirds the length, the tips of all branches terminating in an acute spinous point.

Male.—Length about 5 mm.; wing, 5.5 mm.

Head broken.

Pronotum brown medially, pale on sides; pretergites restrictedly pale yellow. Mesonotal praescutum and scutal lobes chiefly covered by a dark brown discal area, the surface sparsely pruinose; lateral praescutal borders restrictedly obscure yellow; median region of scutum vaguely brightened; scutellum and mediotergite dark brown, the posterior border of the former obscure yellow. Pleura and pleurotergite almost uniformly yellow or testaceous yellow, the mesepisternum vaguely patterned with darker, especially on the ventral sternopleurite. Halteres with stem dirty white, the extreme base brighter; knobs of halteres infuscated. Legs with coxae and trochanters yellow, the fore coxae weakly infuscated; remainder of legs dark brown, the femoral bases restrictedly brightened. Wings with a weak dusky tinge, the prearcular and costal fields more whitened; stigmal area diffuse, more darkened; veins brown, paler in the whitened areas. Costal fringe moderately long and dense. Venation: Sc_1 ending opposite the origin of *Rs*, Sc_2

a short distance from its tip; *Rs* a little shorter than R_{2+3+4}, the latter gently arcuated on proximal half; vein R_3 long and only slightly oblique; cell *1st* M_2 gently widened outwardly, nearly as long as vein M_4; *m-cu* approximately its own length beyond the fork of *M* or at near two-fifths the length of cell *1st* M_2.

Abdominal tergites dark brown, sternites paler; hypopygium chiefly pale brown. Male hypopygium with the apical lobe of basistyle small, oval. Dististyle distinctive; outer blade blackened, flat, terminating in a sharp spine, the outer margin with about four other smaller spines, producing a more or less distinct stellate appearance; at base of this blade and in its axil with a longer blackened rod or spine; inner lobe pale, terminating in the usual two fasciculate setae and with several other smaller bristles. Phallosome distinctive; gonapophyses paired, elongate, very slender, at near two-thirds the length each forked into a slender branch that is slightly longer than the axial one, this more glabrous, all branches terminating in subequal acute spinous points; surface of stem and the axial branch with microscopic scabrous points. Aedeagus stout, gently arcuated, at apex with a deep and narrow split; both apical points with coarse spines or fimbriations.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 25, 1944 (Krauss).

Gonomyia (*Gonomyia*) *stellata* is entirely distinct from the other regional species of the subgenus, especially in the structure of the male hypopygium. The dististyle and phallosome, particularly the elongate, profoundly branched gonapophyses, are noteworthy. In the nature of the phallosome the fly is closest to species such as *G.* (*G.*) *mexicana* Alexander but the relationship is not particularly close.

Gonomyia (Gonomyia) remigera sp. n.

Allied to *flavibasis;* mesonotum chiefly dark brown, sparsely pruinose; scutellum chiefly dark brown; pleura yellow with a narrow dark brown dorsal stripe; halteres infuscated; wings with cell M_2 open by the atrophy of the basal section of M_3; male hypopygium with the outer dististyle on outer margin nearing a blackened triangular lobe or flange; inner dististyle with the outer arm a flattened elongate pale blade; phallosome with a single strongly curved black spine, beyond which point the entire phallosome is pale, not terminating in a spine.

Male.—Length about 3.5 mm.; wing, 4 mm.

Rostrum and palpi black. Antennae with the scape and pedicel yellow, flagellum dark brown; flagellar segments oval. Head above obscure yellow, the central portion of vertex more infuscated.

Pronotum and pretergites light yellow. Mesonotum almost uniformly dark brown, sparsely pruinose; humeral region and lateral borders of praescutum light yellow, more reddened at and near the suture; central region of scutum obscure yellow; scutellum chiefly dark brown, paler posteriorly; mediotergite yellow, more infuscated medially and especially behind. Pleura yellow, with a narrow dark brown dorsal stripe extending from the cervical region to the base of abdomen, passing beneath the root of the halteres; ventral pleurites a little more yellowed than the broad pleural stripe. Halteres infuscated. Legs

with the coxae and trochanters yellow; remainder of legs dark brown, the femoral bases somewhat paler. Wings with a grayish tinge, the prearcular and costal fields more yellowed; stigma oval, medium brown; veins pale brown, more yellowed in the brightened fields. Venation: Sc_1 ending far before the origin of *Rs*, the distance being only a little shorter than *Rs* alone; *Rs* and R_{2+3+4} strongly arcuated, the latter a little shorter; cell M_2 open by the atrophy of basal section of M_3; *m-cu* close to the fork of *M*.

Abdominal tergites dark brown, the incisures paler; sternites and hypopygium yellow. Male hypopygium with the outer dististyle elongate, on outer margin with a strong blackened triangular lobe that is not produced into a spine. Inner dististyle distinctive, the outer arm a flattened elongate pale blade; main body of style subequal in length but stouter. Phallosome with a single strongly curved black spine; beyond this point the phallosome entirely pale, its tip irregularly truncate, not produced into a spine; some distance before tip with a long-oval pale flange or lobe.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, August 14, 1944 (Krauss).

Gonomyia (*Gonomyia*) *remigera* is most similar to species such as *G.* (*G.*) *flavibasis* Alexander (*tuberculata* Alexander), differing especially in the structure of the male hypopygium, particularly of the dististyles and phallosome.

Gonomyia (Gonomyia) ostentator sp. n.

Allied to *expansa;* size large (wing, male, 5.5 mm.); rostrum black; antennae with scape and pedicel yellow; thoracic pleura yellow, with a broad dorsal dark brown stripe and a shorter and narrower ventral one; knobs of halteres darkened; wings with a grayish tinge, the stigma and a vague seam over the cord darker; cell *1st* M_2 closed; male hypopygium with the outer dististyle an elongate flattened blade, not provided with a lateral spine; inner dististyle with the outer margin of the main body elevated into a glabrous darkened flange, subequal in area to the dusky outer blade of the style; phallosome with a single well-developed spine, the apex beyond this large, complicated by outgrowths, the actual tip pale and truncated.

Male.—Length about 5 mm.; wing, 5.5 mm.

Female.—Length about 6 mm.; wing, 6 mm.

Rostrum and palpi black. Antennae with scape and pedicel light yellow, flagellum dark brown; basal flagellar segments long-oval. Head above orange, the center of vertex more or less infuscated.

Pronotum and pretergites light yellow. Mesonotal praescutum and scutum chiefly dark brown, the median region of the latter, and the scutellum, obscure brownish yellow; lateral praescutal borders yellow; mediotergite yellow, the posterior border broadly dark brown, the basal portion with a more or less developed central spot. Pleura and pleurotergite yellow, with a conspicuous dorsal dark brown stripe extending from the cervical sclerites to the mediotergite, as described; a second narrower dark stripe on the ventral sternopleurite, crossing the bases of the mid-coxae onto the meron; the broad pale stripe between these

darkened lines more whitened than the remainder of pleura. Halteres with stem pale brown, darker at extreme base, knob dark brown. Legs with the coxae yellow, the middle pair restrictedly darkened, as described; trochanters yellow; remainder of legs brownish black to black. Wings with a grayish tinge, the prearcular and costal fields somewhat more yellowed; stigma small, oval, brown; a vaguely indicated darkened cloud over the cord; veins brown, more yellowed in the brightened fields. Venation: *Sc* short, Sc_1 ending a distance before origin of *Rs* that is about two-fifths the length of the latter, Sc_2 near its tip; *r-m* arcuated, at or close to the fork of *Rs*, the basal section of R_5 short to lacking; vein R_4 elongate, decurved toward wing tip, more than three times vein R_3; cell *1st* M_2 closed; *m-cu* at or close to fork of *M*.

Abdominal tergites dark brown, the posterior angles or even the entire border yellow; sternites and hypopygium yellow. Male hypopygium with the basistyle not produced apically. Outer dististyle an elongate flattened blade, the outer surface with very long conspicuous setae; face of style with a long oblique darkened flange extending over about one-half the length of the organ. Inner dististyle shorter, the main body stout, its outer margin elevated into a glabrous darkened flange, subequal in area to the flattened dusky outer blade of the style, the latter with the seta placed far basad; fasciculate seta at apex of a small lobe. Phallosome very large and complex, with a single developed, very powerful blackened spine near base, the second spine very small and weak; beyond the spines the phallosome is greatly expanded and complex in structure, bearing an outer pale blade-like appendage, the actual tip arising from the face of the expanded body, strongly curved, truncated and pale at tip.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, March, 1945 (Krauss). *Allotopotype*, ♀, August 25, 1944 (Krauss).

Although similar and related to species such as *Gonomyia* (*Gonomyia*) *expansa* Alexander and *G.* (*G.*) *remota* Alexander, the present fly is quite distinct in many details of structure of the male hypopygium, especially both dististyles and the phallosome.

Molophilus Curtis

Molophilus (**Molophilus**) **procax** sp. n.

Belongs to the *gracilis* group and subgroup; general coloration black, evidently pruinose; antennae short; knobs of halteres obscure yellow; fore legs blackened, middle and posterior femora with bases broadly yellowish; wings with a strong brownish tinge; basal section of R_{4+5} relatively short, only about one-third R_{2+3}; male hypopygium with the two dististyles subequal in length, of distinctive conformation.

Male.—Length about 4.5 mm.; wing, 5 mm.

Rostrum and palpi black. Antennae short, black throughout; flagellar segments cylindrical, with long coarse verticils that exceed the segments in length. Head black, pruinose.

Pronotum black, the scutellum and pretergites yellow. Mesonotum chiefly black, evidently pruinose, the surface of the unique type badly discolored; humeral region of praescutum restrictedly light yellow;

scutellum behind vaguely more reddened; mediotergite behind and the pleurotergite reddish brown. Pleura blackened, presumably pruinose in fresh specimens. Halteres with stem dusky, knob obscure yellow. Legs with fore coxae infuscated; remaining coxae yellow; trochanters yellow; fore legs blackened; middle and posterior femora with the bases broadly yellowish, the remainder blackened. Wings with a strong brownish tinge, vaguely more suffused in cell *M* adjoining vein *Cu;* prearcular field yellow; veins brown. Venation: Sc_1 ending about opposite R_2; basal section of R_{1+3} relatively short, only about one-third R_{2+3}; petiole of cell M_3 about one-half longer than the gently sinuous *m-cu;* vein *2nd A* ending nearly opposite the posterior end of *m-cu*.

Abdomen, including hypopygium, black. Male hypopygium distinctive; ventral lobe of basistyle slender, clavate; mesal lobe broader and slightly shorter, near apex with the margin produced laterad into a small blackened tooth. Both dististyles arising close together in the notch of the basistyle. Outer dististyle stouter, on outer half strongly sinuous, the apex produced into a slender upcurved spine; outer margin with a few coarse retrorse spinulae, the more basal ones larger; inner margin at beginning of the sinuous outer portion with numerous microscopic spinulae. Inner dististyle a slender simple rod, narrowed very gradually into a long straight spine, the outer surface of style for most of its length with appressed spinulae, the surface with further abundant setulae and a few long scattered setae. Phallosomic structure terminating in a small obtuse point; surface of plate with abundant setulae. Aedeagus elongate.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Cuernavaca, altitude 5000 feet, June, 1945 (Krauss).

The only described species with which the present fly requires comparison is ***Molophilus* (*Molophilus*) *retrorsus*** Alexander, which has the male hypopygium entirely different in structure.

Molophilus (Molophilus) bellona sp. n.

Belongs to the *plagiatus* group; size relatively large (wing, male, about 5 mm. or more); antennae of male elongate, the flagellar segments fusiform, with long outspreading verticils; general coloration of body almost uniformly dark brown; halteres obscure yellow; wings subhyaline, the color almost concealed by the unusually long and conspicuous trichia of the veins, these concentrated into patches along the cord; *m-cu* sinuous; male hypopygium with the basistyle an unusually long and slender, nearly straight rod, its apex slightly curved.

Male.—Length about 4–4.3 mm.; wing, 4.8–5.4 mm.; antenna, about 2–2.1 mm.

Rostrum and palpi dark brown. Antennae brownish black throughout, elongate in male, nearly one-half as long as body; flagellar segments elongate-fusiform, with whorls of long outspreading verticils at the thickest portion. Head dark gray.

Thorax almost uniformly dark brown, sparsely pruinose, especially on notum. Halteres obscure yellow. Legs with the coxae and trochanters testaceous yellow; remainder of legs chiefly dark brown to almost black. Wings with the ground subhyaline, almost concealed

by the unusually long conspicuous trichia on the veins, more concentrated on the cord to produce a vague spotted appearance; prearcular field a trifle paler. Venation: R_2 lying shortly beyond the level of *r-m;* petiole of cell M_3 about twice as long as the obliquely sinuous *m-cu;* vein *2nd A* long and sinuous, ending about opposite one-fourth the length of the petiole of cell M_3.

Abdomen, including hypopygium, brownish black to black. Male hypopygium with the beak of the basistyle acute. Outer dististyle unequally bifid at apex, the inner arm longer. Basal dististyle an unusually long slender rod, nearly straight, its apex slightly curved, the extreme base constricted.

HABITAT: Mexico (Morelos). *Holotype*, ♂, Harmsen's Place, Cuernavaca, altitude 5000 feet, July 16, 1930 (Dampf); M. F. 1689. *Paratopotypes*, 2 ♂♂, September 24, 1928; M. F. 1416; *paratype*, 1 ♂, Parque de Revolucion, in the bishop's garden, March 3, 1938; M. F. 1325.

This fly is allied to species such as *Molophilus* (*Molophilus*) *falx* Alexander, *M.* (*M.*) *subsagax* Alexander, and others, differing especially in the structure of the male hypopygium, particularly the basal dististyle.

Molophilus (Molophilus) incognitus sp. n.

Belongs to the *plagiatus* group; general coloration light brown, sparsely pruinose; antennae (male) short, brown throughout; femora and tibiae obscure yellow, infuscated at tips; wings yellowish subhyaline, veins and trichia infuscated; male hypopygium with the arms of the outer dististyle unequal, the lower one stouter, strongly upturned at apex; basal dististyle a long gently curved blackened rod, narrowed to the acute tip.

Male.—Length about 4–4.5 mm.; wing, 4.5–5 mm.

Rostrum and palpi black. Antennae short, if bent backward scarcely reaching the wing root, brown throughout; flagellar segments oval, with long verticils. Head dark gray.

Pronotum yellowish brown; pretergites light yellow. Mesonotum almost uniformly light brown, sparsely pruinose; humeral region of praescutum obscure yellow; in cases, the scutellum vaguely brightened; suture between mediotergite and pleurotergite yellow. Pleura infuscated. Halteres weakly darkened, base of stem restrictedly yellow. Legs with the coxae and trochanters obscure yellow; femora and tibiae obscure yellow, broadly infuscated at tips; tarsi brownish black. Wings yellowish subhyaline, the ground much hidden by long brown macrotrichia; veins and trichia infuscated, the latter more or less concentrated along the cord. Venation: R_2 lying a short distance beyond the level of *r-m; m-cu* oblique, about one-half the petiole of cell M_3; vein *2nd A* relatively long and sinuous, ending about opposite the base of the petiole of cell M_3.

Abdomen dark brown, including hypopygium. Male hypopygium with the beak of basistyle very slender, blackened. Outer dististyle with the arms unequal, the lower stouter, strongly upturned at apex. Basal dististyle a long simple gently curved blackened rod, enlarged at

base, very gradually narrowed to the acute tip. Aedeagus relatively short and slender.

HABITAT: Mexico (Morelos). ***Holotype***, ♂, Cuernavaca, altitude 5000 feet, July 16, 1930 (Dampf); M. F. 1689. ***Paratopotypes***, ♂♂, February 13–27, 1932 (C. C. Plummer); Dampf M. F. 2480, 2482, 2483, 2491; ***paratypes***, ♂♂, Yautepec, altitude 3900 feet, July 17, 1930 (Dampf); M. F. 1697.

Most similar to ***Molophilus*** (***Molophilus***) ***severus*** Alexander, differing in all details of structure of the male hypopygium, including both dististyles and the aedeagus.

Molophilus (Molophilus) telerhabda sp. n.

Belongs to the ***plagiatus*** group; size small (wing, male, 4.5 mm.); antennae short; mesonotum and pleura brownish gray; legs dark brown to black; wings with a weak brownish tinge; male hypopygium with the basal dististyle a very long delicate simple rod that terminates in about a dozen small acute spinules, arranged in a compact group at apex.

Male.—Length about 4 mm.; wing, 4.5 mm.; antenna about 1.1 mm.

Rostrum brownish gray, conspicuously hairy; palpi dark brown. Antennae short, dark brown throughout; flagellar segments subcylindrical, the ends truncated; longest verticils of more basal segments very long, fully three times the segments, those of outer segments shorter. Head light gray.

Pronotum brown; pretergites light yellow. Mesonotum chiefly dark brown, pruinose with gray; humeral region of praescutum more obscure yellow. Pleura dark plumbeous gray; dorsopleural region dusky. Halteres pale yellow. Legs with the coxae dark brown; trochanters obscure brownish yellow; femora brown, paler basally; remainder of legs passing through dark brown to black; a modified region at base of fore tibia. Wings with a weak brownish tinge, the prearcular and costal fields light yellow; veins pale brown, the trichia a little darker. Venation: R_2 lying a short distance beyond level of ***r-m***; ***m-cu*** straight, a little less than one-half the petiole of cell M_3; vein ***2nd A*** relatively long, ending just beyond ***m-cu***.

Abdomen, including hypopygium, dark brown. Male hypopygium with the beak of basistyle slender. Outer dististyle with the stem long and slender, arms unequal, the inner one slender and sinuous. Basal dististyle distinctive, appearing as a very long delicate simple rod that juts caudad beyond the level of the basistyle; outer half of approximately uniform diameter or beoming even thicker toward the tip, the apex terminating in about a dozen small acute spinules, their points directed straight outward; a few small setigerous punctures along style, chiefly on outer portion. Phallosome a small oval glabrous plate. Aedeagus elongate, slender, subequal in length to the basal dististyle.

HABITAT: Mexico (Guanajuato). ***Holotype***, ♂, Irapuato, altitude 5820 feet, November 11, 1927 (Dampf); M. F. 1311.

Molophilus (***Molophilus***) ***telerhabda*** is very different from all other regional species of the genus, being most similar to species such as ***M.*** (***M.***) ***ductilis*** Alexander, yet quite distinct in the structure of the male hypopygium, especially the basal dististyle.

BOOK NOTICES

INSECT MICROBIOLOGY, by EDWARD A. STEINHAUS. Pages x+763, 1946. Comstock Publishing Company. Price $7.75.

The publication of this book is a milestone in the scientific comprehension of the relations between the multitude of insects and microorganisms. As far as the reviewer knows, no such treatment of the subject has yet appeared, even in shorter form. It will undoubtedly be a blessing to the scientists who have need of a compact survey of this rapidly expanding field of knowledge.

As Dr. Steinhaus notes in his preface, the recent war, conducted in many parts of the world with varied climates, gave America greater consciousness of the role of insects in the transmission of diseases of man, animals and plants. He deplores the situation faced at the time, with established knowledge widely scattered and unorganized, and offers his book as a more compact treatment, necessarily abridged in detail although comprehensive in scope. He treats both insects and the related mites and ticks in their relations with all significant microorganisms: bacteria, protozoa, yeasts, fungi, rickettsiae, spirochaetes and viruses. In launching this pioneer volume he warns reviewers that errors may be expected, but evidently he has made every possible effort to keep his statements in harmony with the findings of specialists and this reviewer, for one, does not care to seek minor errors in a work of such obvious value. An author is not to be condemned for errors in a work of extensive correlation as he might be for errors in his own specialty.

Following a brief introduction the book contains twelve chapters on Extracellular Bacteria and Insects, Specific Bacteria Associated with Insects, Intracellular Bacteriumlike and Rickettsialike Symbiotes, Rickettsiae, Yeasts and Insects, Fungi and Insects, Viruses and Insects, Spirochaetes Associated with Insects and Ticks, Protozoa and Insects (Except Termites), Protozoa in Termites, Immunity in Insects and Methods of Procedure. Thus the treatment is broadly biological and the book is of interest not only to medical entomologists but to plant pathologists, bacteriologists, apiarists and biologists in general.

It is impossible in the usual scope of book notices in the ANNALS to treat a volume of this size in great detail, but as examples of the judicious organization of the book two chapters are excellent. In his treatment of specific bacteria the author clarifies his use of the nomenclature and then, following Bergey's *Manual of Determinative Bacteriology*, tabulates the classification and records with brief notes on culturing, staining and host relations of each species known to be associated with insects. This catalogue covers fifty pages. In the chapter on viruses the treatment is in three divisions covering, respectively, virus diseases of insects, vectors of pathogenic viruses of man, animals and plants, and finally bacteriophage, of which little information is to be had. Elsewhere the arrangement of materials is equally convenient for reference.

Eighty-nine pages of references are evidence of the enormous amount of material covered in the preparation of the book. Ample author and subject indices fill the last seventy-one pages.

Paper and printing remind us that the war is over, and with it the unattractive economies to which publishers were forced. The two hundred fifty text figures are not uniformly good, but none is open to serious criticism.

In our age of specialization, with vast detailed knowledge being recorded day by day, vision and comprehension and a measure of temerity are necessary for a scientist to launch upon a project of this kind. But as each of us must specialize if sound research is to continue, so must each of us retain some appreciation of broader fields about him if he is not to become hopelessly narrow. And our detailed discoveries can attain their greatest value to mankind only if someone will leave his laboratory now and then to lay them into a significant mosaic. For this reason we should be grateful to authors who have the vision and comprehension shown by Dr. Steinhaus in preparing this book, and the temerity to risk those critical reviews which seek out the inevitable errors!—A. W. L.

CHECKLIST OF THE COLEOPTEROUS INSECTS OF MEXICO, CENTRAL AMERICA, THE WEST INDIES AND SOUTH AMERICA, PART IV, by RICHARD E. BLACKWELDER. Pages iii+551 to 763, 1946. United States National Museum Bulletin 185. For sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Price 50 cents.

The fourth part of Blackwelder's tremendous compilation continues the checklist of the Polyphaga, covering the families Cerambycidae, Chrysomelidae and Brucidae.

With the appearance of part four this great undertaking approaches completion, with only six families of the classification as outlined in the introduction yet to be covered. One can well imagine that Dr. Blackwelder will find relief as well as satisfaction in its consummation and can only hope that the monotony of such a task will be rewarded by an adequate realization of the service rendered to taxonomists in this largest of insect orders.—A. W. L.

NOTICE TO MEMBERS AND CONTRIBUTORS

The Annals of the Entomological Society of America, published by the Society quarterly, includes the Proceedings of the Annual Meetings and such papers as may be selected by the Editorial Board.

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